DECLARATION

I, Taro MATSUNAMI, a citizen of Japan, c/o Miyoshi & Miyoshi of Toranomon Kotohira Tower, 2-8, Toranomon 1-chome, Minato-ku, Tokyo 105-0001, Japan, do hereby solemnly and sincerely declare:

That I am well acquainted with the Japanese language and English language; and

That the attached is a true and faithful translation made by me of the Japanese document, namely Japanese Patent Application No.2002-191506 to the best of my knowledge and belief.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further, that these statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the above-captioned application or any patent issuing therefrom.

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[Title of the Invention] OPTICAL PICKUP

[What is Claimed is]

[Claim 1]

An optical pickup comprising:

a first laser beam source for emitting a first laser beam having a first wavelength and power capable of recording;

an integrated device having a second laser beam source for emitting a second laser beam having a second wavelength longer than the first wave length and power capable of recording and receiving means for receiving the first and the second laser beam; and

a polarization beam splitter having polarization selectivity for the first laser beam having the first wavelength, polarization non-selectivity for the second laser beam having the second wavelength and providing a first surface into which the primary laser light is injected, a second surface from which the primary laser light is emitted to the information recording medium side and into which return path light of the primary laser light from the information recording medium is injected and a third surface from which the return path light is emitted to the integrated device side.

[Claim 2]

The optical pickup according to claim 1 wherein the polarization beam splitter passes all of the primary laser light having P polarization in relation to the polarization beam

splitter, while reflects all of the primary laser light having S polarization and reflects all of the secondary laser light regardless of the polarization thereof.

[Claim 3]

The optical pickup according to claim 1 wherein the polarization beam splitter passes all of the primary laser light having P polarization in relation to the polarization beam splitter, while reflects all of the primary laser light having S polarization and passes all of the secondary laser light regardless of the polarization thereof.

[Claim 4]

The optical pickup according to claim 1 wherein the polarization beam splitter passes the primary laser light emitted from the primary laser light source toward the information recording medium side and reflects return path light of the primary laser light from the information recording medium to the integrated device side, reflects the secondary laser light from the secondary laser light source to the information recording medium side and reflects the secondary laser light from the information recording medium to the integrated device side, and

the receiving means receives light that is return path light of the primary laser light and the secondary laser light from the information recording medium, emitted from the polarization beam splitter.

[Claim 5]

The optical pickup according to claim 1 wherein the polarization beam splitter reflects the primary laser light emitted from the primary laser light source toward the information recording medium side and passes return path light of the primary laser light from the information recording medium to the integrated device side, passes the secondary laser light from the secondary laser light source to the information recording medium side and passes the secondary laser light from the information recording medium to the integrated device side, and

the receiving means receives light that is return path light of the primary laser light and the secondary laser light from the information recording medium, emitted from the polarization beam splitter.

[Claim 6]

The optical pickup according to claim 4 or claim 5 wherein the primary laser light has a wavelength of the 650 nm band and that the secondary laser light has a wavelength of the 780 nm band.

[Claim 7]

The optical pickup according to claim 4 or claim 5 further comprising a primary collimator lens for collimating the primary laser light from the primary laser light source disposed

between the primary laser light source and the polarization beam splitter; and a secondary collimator lens for collimating the secondary laser light from the secondary laser light source disposed between the integrated device and the polarization beam splitter.

[Claim 8]

The optical pickup according to claim 7 wherein the polarization beam splitter has an inclined surface that, in order to make the plane of incidence of a parallel light beam of the primary laser light made parallel by the first collimator lens into a circular form, is inclined in relation to the optical axis of that parallel light beam.

[Claim 9]

The optical pickup according to claim 4 wherein the polarization beam splitter functions, in relation to wavelengths of the primary laser light, to pass P polarized light and to reflect S polarized light, and functions, in relation to wavelengths of the secondary laser light, as a total light reflecting polarization beam splitter reflecting both P polarized light and S polarized light.

[Claim 10]

The optical pickup according to claim 5 wherein the polarization beam splitter functions, in relation to wavelengths of the primary laser light, to reflect S polarized

light and to pass P polarized light, and functions, in relation to wavelengths of the secondary laser light, as a light passing member that passes both P polarized light and S polarized light.

[Claim 11]

The optical pickup according to claim 4 or claim 5 further comprising a collimator lens that collimates the primary laser light and the secondary laser light traveling from polarization beam splitter to an objective lens disposed between the polarization beam splitter and the objective lens.

[Claim 12]

The optical pickup according to claim 4 wherein the primary laser light source, the integrated device and the polarization beam splitter are disposed such that an optical axes connecting therebetween are positioned on the same plane, and

the primary laser light source is disposed such that the direction of polarization of the primary laser light is parallel to the plane and the secondary laser light source is disposed such that the direction of polarization of the secondary laser light is perpendicular to the plane.

[Claim 13]

The optical pickup according to claim 5 wherein the primary laser light source, the integrated device and the polarization beam splitter are disposed such that an optical

axes connecting therebetween are positioned on the same plane, and

the primary laser light source is disposed such that the direction of polarization of the primary laser light is parallel to the plane at a position where the primary laser light is injected into the polarization beam splitter and the secondary laser light source is disposed such that the direction of polarization of the secondary laser light is perpendicular to the plane at a position where the secondary laser light is injected into the polarization beam splitter.

[Detailed Description of the Invention]

[0001]

[Technical Field to Which the Invention Belongs]

The present invention relates to an optical pickup used for recording or reproducing optical information recorded to a medium such as an optical disk or the like.

[0002]

[Prior Art]

DVD's (Digital Versatile Disc) that have approximately seven times the capacity of CD's (Compact Disc) have rapidly gained in popularity in recent years. Further, DVD-videos that are capable of being reproduced in high-volume are replacing VHS and the like, tape mediums used as mediums for renting and distribution of contents of movies and other material.

[0003]

Moreover, standards for recording such as DVD-RAM, DVD-R, DVD-RW, DVD+R and DVD+RW are becoming commonplace for PC drives and video recorder units.

[0004]

Recordable CD-R is already commonly used.

[0005]

In light of the above, recording functions for either the 650 nm band for DVD or the 780 nm band for CD are required in an optical disk recording device.

[0006]

Further, compatibility in both recording and

reproduction is needed for all of the various standards used for DVD, however the structure and functions of an optical pickup used for this are complex.

[0007]

The need for such devices to be inexpensive, small and lightweight are increasing due to the demands of the general population, thus development of a simple, compact and inexpensive optical pickup, that is nonetheless complex and replete with multiple functions, is required.

[0008]

An optical pickup furnishing the above functions is called a two wavelength recording pickup.

[0009]

Generally, such a two wavelength recording pickup must fulfill the following requirements.

[0010]

1. Optical system dependent on polarization-Optical system independent of polarization

In a DVD recording type pickup, due to the combining of a PBS (polarized light beam splitter) and a wavelength plate (in a polarized light system) the efficiency of outward path (i.e. from the source) and return path should approach 100percent and recording power must be maintained while the load on the laser light source is decreased.

[0011]

In the case of a CD system the load on the laser light source is not so great, further a large number of CD disks with

substantial birefringence are circulating in the market. Accordingly, in the CD line, polarized light independent systems have become the practical standard due to the need to avoid the side effect of deteriorating replay.

[0012]

2. Beam shaping

In order to effectively utilize the elliptical shaped beam intensity distribution of laser emitted light, normally in the case of DVD recording optical systems, a method is used in which a wedge shaped transmissive part is inserted making the intensity distribution round (beam formation). Beam formation is especially important in the case of DVD-RAM where high recording power is required. Limitations applying to beam formation include 1) it must be performed in parallel light beams and 2) beam formation in two wavelengths simultaneously in the same prism is difficult due to chromatic aberration.

[0013]

In the case of CD systems the above described load on the laser source is light and such beam formation is unnecessary.

[0014]

FIG. 14 provides an example of a conventional two wavelength recording pickup that fulfills the above described requirements in outline.

[0015]

As shown in FIG. 14, a DVD laser light source 501, a collimator lens 502, a grating 503, a front monitor 504, a polarized light beam splitter 505, a 1/4 wavelength plate 506,

a dichroic mirror 507, a mirror 508, a secondary collimator lens 509, a detecting lens 510, light receiving elements 511, an integrated device providing a CD laser light source 512, a collimator lens 513, a mirror 514 and a secondary front monitor 515. The polarized light beam splitter 505 provides the above described function for intensity distribution formation.

[0016]

After being emitted from the CD laser light source 512, CD laser light of the above described pickup is collimated at the collimator lens 513 passing via the mirror 514 (without undergoing beam formation) and is directed to an optical disk not shown in the drawing. Following the same path, returning light from the optical disk returns to the receiving elements inside the laser light source 512.

[0017]

DVD laser light is emitted from the DVD laser light source 501 as P polarized light waves and after being made parallel at the collimator lens 502, passes via the grating 503 and is injected from an end 505a of the polarized light beam splitter (PBS) 505 before being reflected at a reflecting surface 505b. Thereafter, this DVD laser light passes via a PBS film surface 505d and is emitted from the other end 505c, before being formed into circular polarized light at the wavelength plate 506, attached so as to be in contact with the end 505c. The laser light is then directed to an optical disk not shown in the drawing. Returning light from the optical disk is made into S polarized light at the wavelength plate 506 and is reinjected into the

end 505c of the polarized light beam splitter 505, reflected at the PBS film surface 505d of the polarized light beam splitter 505 (return path optical system is separated) and reaches the light receiving elements 511 via the detecting lens 510, after being collimated at the secondary collimator lens 509.

[0018]

However, this pickup has separate respective collimator systems for the outward path and return path at the DVD side for example and as there are basically no common parts of the CD side and DVD side, the structure becomes complex as a large number of parts are required notwithstanding the integrated device.

[0019]

FIG. 15 and FIG. 16 relate to an example of an optical pickup (Japanese Patent Application Laid-Open No. 6-325405) similar to the conventional optical pickup described above.

[0020]

This pickup has a beam forming means for 780 nm band laser light to allow for cases when the output of the laser light source that outputs 780 nm band laser light is insufficient, and is an optical system dependent on polarization.

[0021]

That is to say, the CD laser light is emitted from a light source 602, passes via a collimator lens 612 and undergoes beam formation at a prism 613. The laser light is directed to a disk 609 passing via beam splitters 605 and 606, a wavelength plate 607 and objective lens 608. The return path light from the disk

609 passes via the wavelength plate 607 and the beam splitter 606 and is injected into the beam splitter 605. Due to the PBS properties of this beam splitter 605, the optical path of the CD laser light changes to the side having this collimator lens 604. This return path light undergoes a further optical path conversion at a PBS 603, returning to light receiving elements 611 after passing via a detecting system lens 610.

[0022]

In the case of the DVD laser light, this light is emitted from a light source 601 and returns to the beam splitter 605 via the PBS 603 and collimator lens 604. Here, as shown in FIG. 16, the beam splitter 605 operates to reflect short wavelengths (λ 1) and as a PBS for long wavelengths (λ 2). Accordingly, DVD laser light from the light source 601 is reflected at the beam splitter 605, moreover is directed to the disk 609 after passing via the beam splitter 606, the wavelength plate 607 and the objective lens 608. Return path light from the disk 609 returns to the PBS 603 along the same path, passing via the objective lens 608, the wavelength plate 607, the beam splitter 606, the beam splitter 605 and the collimator lens 604. This return path light is separated at the PBS 603 and reaches the light receiving elements 611 passing via the detection system lens 610.

[0023]

The PBS 603 is used to branch the outward and return optical paths in this optical pickup. Accordingly, the optical axis of emitted light and the optical axis of received light

are disposed mutually separated at approximately 90 degrees such that concentration of the light receiving parts is not practically possible.

[0024]

Moreover, the two wavelengths of the CD laser light and the DVD laser light are optical systems dependent on polarization, accordingly there is concern of deterioration in the replay performance of a CD disk having substantial birefringence.

[0025]

Japanese Patent Application Publication Laid-Open No. 10-334500 discloses another example of an optical pickup.

[0026]

This optical pickup is a replay pickup device using an integrated devices that emit and/or receive light for the respective two wavelengths and having a prism for separating and synthesizing the optical paths of the two wavelengths inserted in divergent light, such that the collimator lens is shared.

[0027]

The object of this optical pickup also is the utilization of integrated device, however two integrated devices are required and the same problem of requiring a complex structure persists. Further, this optical pickup is for reproduction and does not provide an optical system that more efficiently utilizes optical properties such as by beam formation and a polarized light system, thus even if high output laser is used

this structure does not actually enable recording to an optical disk.

[0028]

[Problems to be Solved by the Invention]

An object of the present invention is to provide an optical pickup having a simple structure and that is capable of recording using a plurality of wavelengths.

[0029]

[Means for Solving the Problems]

An optical pickup according to the present invention includes a first laser beam source for emitting a first laser beam having a first wavelength and power capable of recording; an integrated device having a second laser beam source an integrated device having a second laser beam source for emitting a second laser beam having a second wavelength longer than the first wave length and power capable of recording and receiving means for receiving the first and the second laser beam; and a prism having polarization selectivity for the first laser beam, polarization non-selectivity for the second laser beam.

[0030]

[Mode for Carrying out the Invention]

Exemplary embodiments of the invention will now be described below with reference to FIGS. 1 to 11. In these drawings, like reference numerals identify like elements.

[0031]

FIG. 1 and FIG. 2 are schematic illustrations of an optical pickup according to a first embodiment of the present

invention.

[0032]

As shown in FIG. 1 and FIG. 2 the optical pickup 100 according to this first embodiment comprises a primary laser light source 101 for emitting a primary laser light having a first wavelength and that is of sufficient power for recording, an integrated device 112 further comprising a secondary laser light source emitting a secondary laser light having a second wavelength that is longer than the first wavelength and that is of sufficient power for recording as well as light receiving means for receiving light from the primary and the secondary laser lights, and a polarized light beam splitter 105 further comprising an inclined surface 117 having light polarization selectivity in respect of the first laser light having the first wavelength, no light polarization selectivity in respect of the second laser light having the second wavelength and that is injected with the primary laser light emitted from the primary laser light source 101, a second surface 155 that emits the primary laser light to an information recording medium side 201 and is injected with return path light of the primary laser light from the information recording medium 201 and a third surface 153 for emitting the return path light to the integrated device side.

[0033]

The laser light source 101 is for example a DVD laser light source emitting the primary laser light having output sufficient for recording (for example a laser light having a

wavelength of the 650 nm band that is a wavelength used for DVD). The angle of rotation with respect to the optical axis of the primary laser light source 101 is set such that the direction of polarization of the primary laser light is P polarization in relation to the polarized light beam splitter 105 (that is to say the direction of polarization in a plane including the X and Y axes in the drawing). This primary laser light source can be obtained from a single laser source as from a laser diode in can package.

[0034]

A primary collimator lens 102 and three beam generating means 103 are disposed between the primary laser light source 101 and the polarized light beam splitter 105.

[0035]

The collimator lens 102 collimates (makes parallel) laser light from the primary laser light source 101.

[0036]

The three beam generating means 103 generates three beams for detecting tracking errors on the optical disk 201 providing the information recording medium. This 103 is comprised for example of a grating.

[0037]

The polarized light beam splitter 105 has for example a first prism 105a and a second prism 105b as shown in FIGS. 1 and 2.

[0038]

The first prism 105a has a first inclined surface 117 that

is injected with the primary laser light from the primary laser light source 101. The normal line n of the first inclined surface 117 is at an inclination in relation to the optical axis of the primary laser light in order to perform beam formation of the primary laser light. In this way the primary laser light having an elliptical shape cross-sectionally is formed into a round shape cross-sectionally (accordingly the first inclined surface 117 is called a beam forming surface or a cross-sectional form forming surface).

FIG. 3 shows how the cross-sectional form of the primary laser light is formed by the first prism 105a.

[0039]

More specifically, referring to FIG. 3, primary laser light L1 from the primary laser light source 101 that has an elliptical form cross-sectionally S1, immediately prior to entering the first prism 105a, is formed into a circular form cross-sectionally S2 by being injected into the inclined surface 117.

[0040]

The angle of inclination of the normal line of the inclined surface 117 in relation to the optical axis of the primary laser light L1 is determined such that the projection of the cross-sectional form S1 to the inclined surface 117 is as cylindrical as possible.

[0041]

In reference to FIG. 3, L1′ shows return path light when the primary laser light L1 returns to the polarized light beam

splitter 105 side after being directed to an optical disk 201. L2 shows the secondary laser light emitted from the secondary laser light source and L2′ illustrates the return path light of this secondary laser light.

[0042]

Referring again to FIGS. 1 and 2, the joining face between the first prism 105a and the second prism 105a is inclined at an angle of 45 degrees in relation to the Y axis in FIG. 1 (this Y axis being in a plane including the optical axis (Z axis) of an objective lens 203 described subsequently and the normal line of the mirror 108 and being perpendicular to the Z axis), and moreover is set parallel to the Z axis.

[0043]

A polarized light beam splitter (PBS) film surface 118 is formed on the joining face. This PBS film surface 118 passes P polarized light from the primary laser light source and reflects S polarized light from the primary laser light source. More specified description is given below.

[0044]

FIG. 4 shows wavelength reflection/transmission properties of the PBS film surface 118.

[0045]

In FIG. 4 the horizontal axis shows the wavelength of light and the vertical axis the ratio of light that is passed. The curved line T_p indicates the ratio of P polarized light that is passed and the curved line T_s represents the ratio of S polarized light that is passed.

[0046]

As shown in FIG. 4, the P polarized light pass ratio T_p is substantially 100 percent in the wavelength band of the primary laser light (the 650nm wavelength region, and in the wavelength band of the secondary laser light (the 780nm wavelength region) is substantially 0 percent. Further, the S polarized light pass ratio T_s is substantially 0 percent (a rate of reflection close to 100 percent) in both the wavelength band region of the secondary laser light and of the primary laser light.

[0047]

A PBS film surface having the wavelength reflection/transmission properties may have a multilayer film structure of eleven layers each sandwiched between glass material described with reference to the explanation of Table 1.

[0048]

[TABLE 1]

A DESIGN EXAMPLE OF PBS/NPBS LAYER FOR WAVELENGTH SELECTION

		MATERIAL	REFRACTIVE INDEX (nd) [587.56 nm]	THICKNESS [nm]
	GLASS	SF57	1.847	
1	L	Na_3AlF_6	1.35	658.89
2	H	TiO_2	2.24	322.7
3	L	Na_3AlF_6	1.35	513.28

4	H	TiO_2	2.24	114.12
5	L	Na_3AlF_6	1.35	495.34
6	H	TiO_2	2.24	139.92
7	L	Na_3AlF_6	1.35	574.28
8	H	TiO_2	2.24	107.23
9	L	Na_3AlF_6	1.35	494.98
10	H	TiO_2	2.24	178.46
11	L	Na_3AlF6	1.35	215.26
	GLASS	SF57	1.847	

ANGLE OF INCIDENCE 45 [deg.]

[0049]

Here, SF57 indicates glass material by SHOTT AG corresponding to the primary and secondary prisms 105a and 105b. Na_3AlF_6 (cryolite) and TiO_2 (titanium oxide) are both well known film materials used in optics. Further, the refractive index is the refractive index in relation to 587.56nm light and the thickness is expressed in nm.

[0050]

$Na_5AL_3F_{14}$ (chiolite), a vapor deposited material having a refractive index equivalent to that of Na_3AlF_6 (nd =1.35), can be used instead. Further, Ta_2O_5 (tantalum pentoxide) can be used in substitution for TiO_2. Again, PBH53W or PBH55 can be substituted for the SF57.

[0051]

In the above described structure, substantially 100 percent of primary laser light having P polarization passes the

PBS film surface 118.

[0052]

In other words, the PBS film surface 118 of the polarized light beam splitter 105 has polarized light selectivity in respect of primary laser light and non selectivity of polarized light in respect of the secondary laser light. That is to say, the polarized light beam splitter 105 passes P polarized light (first polarized light) of the primary laser light and reflects S polarized light (second polarized light) of the primary laser light, moreover, reflects the first and second polarized lights of the secondary laser light.

As shown in FIGS. 1 and 2, the optical pickup 100 has a first front monitor 104 positioned forward of the inclined surface 117, for detection of the power of the primary laser light. The output of the primary laser light that is output from the primary laser light source 101 can be controlled by the signal from this front monitor 104.

[0053]

As shown in FIGS. 1 and 2, this optical pickup 100 also has a wavelength plate 106, mirror 108 and an objective lens 203 disposed between the polarized light beam splitter 105 and the information recording medium 201.

[0054]

The wavelength plate 106 is set to function as a 1/4 wavelength plate in relation to the wavelength (650nm band region) of the primary laser light, thus primary laser light output from the second surface 155 of the second prism 105a is

changed from P polarized light to circular polarized light.

[0055]

The mirror 108 reflects laser light emitted from the wavelength plate 106 toward the information recording medium 201.

[0056]

The objective lens 203 focuses the primary laser light having a parallel beam form from the mirror 108 over a track 201a (FIG. 2) of the information recording medium 201 and emits the reflected divergent light from the 201a to the mirror 108 side again as a parallel beam.

[0057]

FIG. 5 shows the integrated device 112 in detail.

[0058]

As shown in FIG. 5, the integrated device 112 has a secondary laser light source 128 that outputs secondary laser light (laser light having for example, a wavelength of the 780nm band region used for CD) and light receiving means (light receiving elements) 136 for receiving light reflected from the information recording medium 201.

[0059]

The secondary laser light source 128 emits laser light having a wavelength of for example the 780nm wavelength region for the secondary laser light, which laser light is of sufficient power for recording.

[0060]

As shown in FIG. 5, the secondary laser light source 128

is mounted on a cabinet 138 via a submount 129 and a light receiving elements base 135. Here, the secondary laser light source 128 is positioned on the light receiving elements base 135 such that return path light of the primary laser light and the secondary laser light is focused on the same position of the integrated device 112. In other words, the secondary laser light source 128 is set such that optical axes of the return path light of the primary laser light and the secondary laser light onto the light receiving elements 136 are mutually matched, or to explain it in yet another way, the secondary laser light source 128 is set such that the conjugation point of the light emitting point of the primary laser light and light emitting point of the secondary laser light are matching or positioned on the same optical axis. Conjugation point refers to the image point of the light emitting point of the primary laser light from the optical system including the inclined surface and the PBS film surface.

[0061]

In the same way, the light receiving elements or light receiving means 136 is mounted on the light receiving elements base 135 via the cabinet 138.

[0062]

Further, the integrated device 112 has a micromirror 130 that reflects secondary laser light emitted from the secondary laser light source 128 parallel to the planar surface of the light receiving elements base 135 (the Y′ axial direction of FIG. 5) in a direction perpendicular to the planar surface of

the light receiving elements base 135 (the Z′ axial direction of FIG. 5).

[0063]

Moreover, the integrated device 112 has a second laser light front monitor 131 for detecting a constant ratio of secondary laser light emitted from the secondary laser light source 128 and not reflected at the micromirror 130. The condition of the output and power of the secondary laser light emitted from the secondary laser light source 128 can be detected from this second laser light front monitor 131.

[0064]

The integrated device 112 also has a grating 132 that separates the secondary laser light from the micromirror 130 into three beams and acts as a three beam generating means that generates three beams used for tracking error detection. This grating 132 can also be referred to as a three beam generating grating.

[0065]

Again, the integrated device 112 provides hologram elements 133 for diffracting primary laser light and secondary laser light reflected from the information recording medium 201 to diffracted light of order of ± 1, in order to detect focus errors or tracking errors of the primary laser light and secondary laser light on the information recording medium 201.

[0066]

The hologram element 133 has a first region 133L and a second region 133R arranged such that light beams diffracted

at the regions 133L and 133R have finite determined angle, respectively. Each of these regions 113L and 133R has a semi circle form of a circle divided into two.

[0067]

In this way the diffracted light of order of ± 1 of the primary laser light or the secondary laser light diffracted at the regions 133L and 133R form a pair of spots in the mutually disparate directions A and B (in a circle the center of which is a spot formed by 0 order diffracted light, the directions A and B toward different circumferential locations of that circle) over the plane X′ Y′ of FIG. 5.

[0068]

Further as shown in FIG. 5, the light receiving elements 136 have a plurality of light receiving regions 205 to 219.

[0069]

In FIG. 5, light beam 137 shows diffracted light of order of ± 1 from the hologram elements 133L of the primary laser light and the light beam 134, that is diffracted light of order of ± 1 from the hologram elements 133L of the secondary laser light. As shown in that drawing, according to this embodiment the diffracted light of order of ± 1 of the primary laser light and the secondary laser light formed in the same hologram region (for example 133L) is designed so as to be injected into the same light receiving region (for example, 209, 215). In other words, the light receiving elements 136 have a first position light receiving region for receiving primary laser light having a order of refraction refracted in the hologram region and a

second position light receiving region of the same light receiving region for receiving secondary laser light having the same order of refraction and moreover being refracted at that same hologram region.

[0070]

As shown in FIG. 5, the three beam generating grating 132 and the hologram elements 133 form an integrated body as a somewhat circular structure over both surfaces of a member 139, having appropriate optical transmissive properties, that is disposed over the light receiving elements base 135.

[0071]

FIG. 6 shows the spot of each refracted light formed over each of the light receiving regions 205 to 219 of the light receiving elements 136.

[0072]

In FIG. 6 the semi circles A1±, A0±, A2±, B1±, B0 ±, B2± indicated over each of the light receiving regions 205-219 indicate the spot of diffracted light of order of ± 1 from the hologram elements 133 for the three beams of return path light of the primary laser light for example. These three beams are formed as primary laser light from the primary laser light source 101 is separated into three beams by the three beam generating means 103 and each of these three beams is reflected at the optical disk. Specifically:

[0073]

A1 ± : the spot of diffracted light of order of ± 1 from the second region 133R of the first side beam from among the

3 beams

A0 ± : the spot of diffracted light of order of ± 1 from the second region 133R of the main beam from among the 3 beams

A2 ± : the spot of diffracted light of order of ± 1 from the second region 133R of the second side beam from among the 3 beams

B1 ± : the spot of diffracted light of order of ± 1 from the first region 133L of the first side beam from among the 3 beams

B0 ± : the spot of diffracted light of order of ± 1 from the first region 133L of the main beam from among the 3 beams

B2 ± : the spot of diffracted light of order of ± 1 from the first region 133L of the second side beam from among the 3 beams

As shown in FIG. 6 according to this embodiment, spot A2+ and spot B1+ are designed so as to be concentrated between the light receiving regions 207 and 209 and spot A1- and spot and spot B2- are designed so as to be mutually concentrated between the light receiving regions 215 and 217.

[0074]

Further, the first region 133R has lens power of a concave lens in respect of diffracted light of order of +1 and in respect of diffracted light of order of -1 has the lens power of a convex lens. The first region 133L on the other hand has lens power of a convex lens in respect of diffracted light of order of +1 and in respect of diffracted light of order of -1 has the lens power of a concave lens.

[0075]

According to the above configuration, DPP (Differential Push-Pull method) tracking error signals can be generated based on the output from the regions 205 to 219.

[0076]

More specifically, tracking error signal TE_{DPP} is derived as

$$TE_{DPP} = ((V_{207} + V_{217}) - (V_{20} + V_{215})) - k((V_{205} + V_{219}) - (V_{213} + V_{211}))$$

Here, V_{207} is the signal output from each region (for example, region 207).

[0077]

Further, k is a determined constant determined by the separation ratio of the three beams. Here, k = 0, in other words the tracking error signal TE_{PP} as shown below is obtained using the push-pull method from just the main beam signal V_{207}, V_{217}, V_{209}, V_{215}.

[0078]

$$TE_{PP} = (V_{207} + V_{217}) - (V_{209} + V_{215})$$

Further, a focus error signal can be generated based on the signals from region divisions 207a, 207b and 207c, and 217a, 217b and 217c of the regions 207 and 217.

[0079]

More specifically, the focus error signal FE is obtained for example by

$$FE = ((V_{207a} + V_{207c} + V_{217b}) + (V_{209b} + V_{215a} + V_{215c})) - ((V_{207b} + V_{217a} + V_{217c}) + (V_{209a} + V_{209c} + V_{215b}))$$

Here, V_{207a} and the like, show the signal output for each region division (for example region 207a).

[0080]

The hologram 133 and light receiving elements 136 are not restricted to those described above and other conventionally known configurations can be used in order to obtain the tracking error signal TE_{DPP} and the focus error signal FE.

[0081]

As shown in FIGS. 1 and 2 this optical pickup 100 further comprises a second collimator lens 109 for making parallel secondary laser light from the integrated device 112, disposed over the optical path between the integrated device 112 and the polarized light beam splitter 105.

[0082]

The operation of this embodiment will now be described.

[0083]

As shown in FIGS. 1 and 2 primary laser light emitted from a primary laser light source 101 is made parallel at a first collimator lens 102 and the beam is divided into three at a grating 103 providing the three beam generating means. As described, the direction of the polarization of this primary laser light is set so as to be P polarized light in relation to the angle of incidence 117 of a polarized light beam splitter 105.

[0084]

As shown in FIG. 3, each beam separated by the grating 103 enters the inclined surface 117 of the polarized light beam

splitter 105, the cross-sectional form of which is substantially round. The primary laser light L1 in FIG. 3 indicates one of the beams from among those three beams.

[0085]

Each of the beams formed at the inclined surface 117 enters the PBS film surface 118 at an angle of approximately 45 degrees.

[0086]

As described previously, this PBS film surface 118 passes substantially 100 percent of P polarized light of the 650 nm band (FIG. 4). Accordingly, each of the three beams passes the PBS film surface 118 due to this 100 percent pass ratio, before entering the wavelength plate 106 from the second surface 155 of the polarized light beam splitter 105. As also described previously, this wavelength plate 106 operates as a 1/4 wavelength plate in relation to the primary laser light.

[0087]

Accordingly, each of the beams that enters the wavelength plate 106 is converted to circular polarized light by the wavelength plate 106 before being irradiated over the track 201a of the information recording medium 201 via the objective lens 203 and the mirror 108.

[0088]

Return path light reflected at the track 201a passes via the objective lens 203 and the mirror 108 and again enters the wavelength plate 106. While the light reflected from the information recording medium 201 is termed return path light,

light traveling towards the information recording medium 201 from the primary laser light source 101 can be termed outward path light (these same terms being applied in respect of all the embodiments).

Each of the return path lights is converted into S polarized light at the wavelength plate 106 and enters the second surface 155 of the polarized light beam splitter 105 along the Y axis (FIG. 3).

[0089]

Each of the return path lights having entered the second surface 155 enters the PBS film surface 118, again at an angle of incidence of approximately 45 degrees.

[0090]

As described previously, the PBS film surface 118 reflects S polarized light regardless of the wavelength (FIG. 4). Accordingly, each of the return path lights is reflected to the X axis by the PBS film surface 118, and its emitted from the third surface 153 of the polarized light beam splitter 105 before entering the second collimator lens 109.

[0091]

Each of the return path lights that enters the second collimator lens 109 passes via the hologram elements 133 of the integrated device 112 and is focused to the light receiving regions 205 to 219 (FIG. 5).

[0092]

DPP tracking error signals and focus error signals as well as read signals are generated from signals from the light

receiving regions 205 to 219.

[0093]

Secondary laser light emitted from the secondary laser light source 128 (FIG. 5) of the integrated device 112 is separated into three beams by the grating 132 for three beam generation.

[0094]

Each of the beams separated at the three beam generating grating 132 enters the second collimator lens 109 and is made parallel.

[0095]

Each of the collimated beams enters the third surface 153 of the polarized light beam splitter 105 along the X axis, before entering the PBS film surface 118 at an angle of incidence of approximately 45 degrees.

[0096]

As described above, the PBS film surface 118 reflects substantially 100 percent of secondary laser light of the 780 nm band, regardless of the condition of polarization (FIG. 4). Accordingly, each beam is reflected at the PBS film surface 118 to the Y axial direction of FIG. 1 and FIG. 2.

[0097]

Each of the beams reflected at the PBS film surface 118 is emitted from the second surface 155 and converted at the wavelength plate 106 to for example a suitable elliptical polarization.

[0098]

Each of the beams converted at the wavelength plate 106 to a suitable elliptical polarization passes via the mirror 108 and the objective lens 203 and is focused on the track 201a over the information recording medium 201.

[0099]

Return path light reflected at the track 201a passes via the objective lens 203 and the mirror 108 and enters the wavelength plate 106 where the light is converted again to for example a suitable substantially linear polarization (for example S polarization) or another elliptical polarization.

[0100]

Each of the beams thus converted enters the second surface 155 of the polarized light beam splitter 105 along the Y axis and enters the PBS film surface 118 at an angle of incidence of approximately 45 degrees.

[0101]

Each of the beams that enters the PBS film surface 118 is reflected in accordance with the reflective properties of the PBS film surface 118 (FIG. 4) to the X axial direction and is emitted from the third surface 153 of the polarized light beam splitter 105.

[0102]

Each of the beams emitted from the third surface 153 is concentrated onto the hologram elements 133 after being formed into a convergent beam at the second collimator lens 109.

[0103]

Each of the beams concentrated onto the hologram elements

133 are separated respectively into diffracted light of order of ± 1 at the hologram regions 133L and 133R and form the respective spots on the light receiving regions 205 to 219.

[0104]

As each spot is formed in the light receiving regions 205 to 219 tracking error signals, focus error signals and read signals are generated for the secondary laser light in the same manner as for the primary laser light, based on the output from each appropriate light receiving region 205 to 219.

[0105]

Accordingly, this embodiment furnishes the following effects.

[0106]

(1) The secondary laser light source 128 providing the source of output for the secondary laser light and the light receiving regions 205 to 219 providing a light receiving means for the primary and the secondary laser lights are integrated in one integrated device 112, and the light receiving regions 205 to 219 can receive light that is return path light of the primary and secondary laser lights.

[0107]

(2) As the primary laser light source 101 is disposed so as to be separate from the integrated device 112 the structure can be realized with for example simply a single laser diode in can package and heat release and cooling can be performed easily.

[0108]

(3) The wavelength plate 106 functions as a 1/4 wavelength plate having 1/4 wavelength differentiation in the 650 nm band but does not operate as a 1/4 wavelength plate for the 780 nm band, such that light output from the wavelength plate 106 is of an elliptical polarization. Accordingly return path light of the secondary laser light is not polarized into a perfect linear polarization after passing the wavelength plate 106 and is an elliptical polarization being a mixture of P polarized light and S polarized light. As shown in FIG. 4 however, the PBS film surface 118 reflects all light of the 780 nm band regardless of the direction of polarization. Accordingly, substantially all return path light of secondary laser light returns to the integrated device 112 enabling the tracking error signals, focus error signals and read signals to be obtained from the appropriate light beam separation and calculation processes.

[0109]

(4) As inside the integrated device 112 the conjugation point of the light emitting point of the primary laser light (the image point of that light emitting point from the optical system including the inclined surface and PBS film surface) and the light emitting point of the secondary laser light are set so as to be matching or positioned on the same optical axis, a position offset to a divisional line of the hologram elements 133, the objective lens 203 and a pupil substantially vanish, enabling satisfactory tracking error signals and focus error signals to be obtained.

[0110]

(5) Light output can be easily controlled by the signal from the front monitor 104.

[0111]

In the description of the above embodiment the primary laser light has a wavelength of the 650 nm band and the secondary laser light has a wavelength of the 780 nm band, however it is also suitable for the primary laser light to have a wavelength of the 400 nm band or the 780 nm band, moreover the secondary laser light may have a wavelength of the 650 nm band or the 400 nm band.

[0112]

In this first embodiment the polarized light beam splitter 105 comprises the prisms 105a and 105b and the PBS film surface 118, however here, and in respect of subsequently described embodiments, the polarized light beam splitter 105 can be referred to as a prism.

[0113]

FIG. 7 shows a schematic illustration of a second embodiment of an optical pickup according to the present intention.

[0114]

In FIGS. 1 to 6 those elements having like reference numerals indicate those elements that are similar or the same as the respective elements of the first embodiment.

[0115]

The optical pickup 240 of this second embodiment is of

substantially the same configuration as the optical pickup according to the first embodiment.

[0116]

That is to say, as shown in FIG. 7, this optical pickup comprises a primary laser light source 241 for emitting a primary laser light (wavelength of the 650 nm band) having sufficient power for recording, a polarized light beam splitter 244 including a polarized light beam splitting (PBS) film surface 118, and an integrated device 112 further comprising a secondary light source 128 for emitting a secondary laser light (having a wavelength of the 780 nm band) and having sufficient power for recording as well as light receiving means for receiving light from the primary and the secondary laser lights. Further, the PBS film surface 118 has the configuration as shown in Table 1 and the wavelength reflection/transmission properties as shown in FIG. 4.

[0117]

The points of difference between the optical pickup according to the second embodiment and that according to the first are as follows.

[0118]

(1) In comparison to the primary laser light source 101 of the first embodiment, the primary laser light source 241 has high-power output, or emits primary laser light that is close to perfectly circular, having a small aspect ratio of emitted light intensity distribution. Accordingly, beam formation is not required when recording to the optical disk 201 is performed

using the primary laser light, and instead of the polarized light beam splitter 105 having an inclined surface 117 as in the case of the first embodiment, this second embodiment uses a polarized light beam splitter 244 having a cuboid form.

[0119]

(2) The second embodiment uses a single collimator lens 245 instead of the two collimator lenses 102 and 109 used in the first embodiment. That is to say, the single collimator lens is used jointly for both the first and the second laser lights. As shown in the drawing, the collimator lens 245 is disposed between the polarized light beam splitter 244 and the objective lens 203.

[0120]

This optical pickup according to the second embodiment has the same effects as the optical pickup of the first embodiment.

[0121]

Further, the optical pickup of the second embodiment has a small and simple optical system in comparison to the optical pick up of the first embodiment.

[0122]

FIG. 8 shows a schematic illustration of an optical pickup according to a third embodiment of the present invention.

[0123]

Like reference numerals are applied for elements of this third embodiment that are the same as those of the first and second embodiments and a description of those elements is

omitted.

The points of similarity between the optical pickup 800 of this third embodiment and the optical pickup of the second embodiment are as follows.

[0124]

(1) The polarized light beam splitter 844 having a PBS film surface 818 is of a cubic form.

[0125]

(2) The collimator lens 245 is disposed between the polarized light beam splitter 844 having the PBS film surface 818 and the mirror 108 so that the collimator lens 245 can be used for both the primary and secondary laser lights.

[0126]

On the other hand, the points of difference between the optical pickup 800 of this third embodiment and the optical pickup of the second embodiment are as follows.

[0127]

(1) The PBS film surface 118 has the wavelength reflection/transmission properties shown in FIG. 9.

[0128]

(2) In view of the wavelength characteristics as shown in FIG. 6, the integrated device 112, having the secondary laser light source 128 and the light receiving elements 136, is disposed along the Y axial direction and opposing the collimator lens 245, the polarized light beam splitter 844 having the PBS film surface 818 being disposed therebetween. The primary laser light source 801 is disposed along the X axial direction,

orthogonal to the Y axis.

[0129]

More specifically, it is further described as follows.

[0130]

As shown in FIG. 8, the optical pickup 800 comprises a primary laser light source 801 for emitting a primary laser light (wavelength of the 650 nm band) having sufficient power for recording, a polarized light beam splitter 844 including a polarized light beam splitting (PBS) film surface 818, and an integrated device 112 further comprising a secondary light source for emitting a secondary laser light (having a wavelength of the 780 nm band) and having sufficient power for recording as well as light receiving means for receiving light from the primary and the secondary laser lights.

[0131]

The primary laser light source 801 is comprised for example of a DVD laser light source emitting the primary laser light, and sets the angle of rotation with respect to the light axis such that the direction of the polarization of the primary laser light is S polarization in relation to the polarized light beam splitter 844 (in other words, polarization of a direction orthogonal to the plane including the X axis and the Y axis in the drawing). The primary laser light source 801 can be a single laser source like what is known as a laser diode in can package as described above.

[0132]

A three beam generating means 803 is disposed over the

optical path between the primary laser light source 801 and the polarized light beam splitter 844. This three beam generating means 803 generates three beams for detecting tracking errors on the information recording medium 201 and is comprised for example of a grating.

[0133]

The polarized light beam splitter 844 has for example a primary prism 844a and a secondary prism 844b, as shown in FIG. 8. The primary prism 844a has a first surface 817 into which primary laser light from the primary laser light source 801 enters.

[0134]

The joining face between the primary prism 844a and the second prism 844b is inclined at an angle of 45 degrees in relation to the Y axis in FIG. 3 (the Y axis of FIGS. 1 to 3) and parallel to the optical axis of the objective lens 203.

[0135]

A polarized light beam splitter (PBS) film surface 818 is formed on the joining face. This film surface 818 passes P polarized light from the primary laser light source and reflects S polarized light from the primary laser light source.

[0136]

More specifically, FIG. 9 shows wavelength reflection/transmission properties of the PBS film surface 818.

[0137]

In FIG. 9 the horizontal axis shows the wavelength of light and the vertical axis the ratio of light that is passed.

The three curved lines T_p indicate the ratio of the three incident light beams having P polarization that are passed. The numbers 48.1 degrees, 45 degrees and 41.9 degrees on the curved line T_p indicate the respective angles of incidence of each light beam incident to the PBS film surface 818. The range of these angles of incidence 48.1 degrees to 41.9 degrees is equivalent in this embodiment to the range NA 0.1 of the collimator lens 245. In the same manner, the three curved lines T_s indicate the ratio of the three injected light beams having S polarization that are passed. The meaning of the values 48.1 degrees, 45 degrees and 41.9 degrees on the respective curved lines T_s is the same as the meaning of the values on the three curved lines T_p.

[0138]

Accordingly, the PBS film surface 818 has the following wavelength transmission properties. The ratio of S polarized light of the 650 nm band (first polarization) passed is substantially 0 percent (a rate of reflection of approximately 100 percent). The ratio of S polarized light of the 780 nm band that is passed is approximately 100 percent. In respect of P polarized light (the second polarized light), substantially 100 percent of light in both of those wavelength bands is passed. This applies also with respect to parallel light and divergent light (for example a light beam the angle of incidence to the PBS film surface 818 of which is in the range of 48.1 degrees to 41.9 degrees).

[0139]

a PBS film surface these wavelength reflection/transmission properties has a multilayer film structure of eleven layers each sandwiched between glass materials as shown in Table 2.

[0140]

[TABLE 2]

A DESIGN EXAMPLE OF PBS/NPBS LAYER FOR WAVELENGTH SELECTION

		MATERIAL	REFRACTIVE INDEX (nd) [587.56 nm]	THICKNESS [nm]
	GLASS	SF57	1.847	
1	L	LaF_3	1.55	106.46
2	H	TiO_2	2.24	121.18
3	L	LaF_3	1.55	45.00
4	H	TiO_2	2.24	130.45
5	L	LaF_3	1.55	86.73
6	H	TiO_2	2.24	131.12
7	L	LaF_3	1.55	86.72
8	H	TiO_2	2.24	130.44
9	L	LaF_3	1.55	44.98
10	H	TiO_2	2.24	121.14
11	L	LaF_3	1.55	106.36
	GLASS	SF57	1.847	

[0141]

Here, SF57 indicates glass material by SCHOTT AG corresponding to the primary and secondary prisms 844a and 844b. LaF_3 and TiO_2 are each widely known film materials in the optical field. As shown in the drawing, the refractive index is the refractive index in relation to 587.56nm light and the thickness is in units of nm.

[0142]

As a substitute for SF57, PBH53W or PBH55 or the like can be used for the glass material.

[0143]

In accordance with the above described configuration, substantially 100 percent of primary laser light from the primary laser light source 801 having S polarization is reflected at the PBS film surface 818 even when divergent light.

[0144]

As shown in FIG. 8 this optical pickup 800 further provides a wavelength plate 806, a mirror 108 and an objective lens 203 disposed on the optical path between the polarized light beam splitter 844 and the information recording medium 201.

[0145]

In the same manner as the previous embodiments, the wavelength plate 806 is set to function as a 1/4 wavelength plate in respect of primary laser light of the 650 nm band. Accordingly, primary laser light emitted from the primary laser light source 801 is converted from S polarization to circular polarization at the wavelength plate 806.

[0146]

The mirror 108 and objective lens 203 have the same operation and configuration as those described with respect to the first and second embodiments.

[0147]

The operation of this third embodiment will now be described.

[0148]

Primary laser light of S polarization from the primary laser light source 801 is emitted along the X axis.

This primary laser light has intensity distribution that in FIG. 8, extends longer in the parallel direction of the page and shorter in the direction orthogonal to the page, moreover, as this longer direction of the intensity distribution is equivalent to the radial direction orthogonal to a track on the information recording medium 201, this results in improved lens shift properties.

[0149]

The primary laser light is separated into three beams by the three beam generating means 803.

[0150]

Each beam thus separated enters the first surface 817 of the polarized light beam splitter 844.

[0151]

Thereafter, each of these beams enters the PBS film surface 818 as divergent light centered on an angle of incidence of approximately 45 degrees.

[0152]

As described above, the ratio of S polarized light of the 650 nm band that is passed at the PBS film surface 818 is substantially 100 percent (a pass ratio of 0 percent) even for divergent light (FIG. 9). Accordingly, this incident light is reflected along the Y axis at the 844 that has a reflection ratio of substantially 100 percent, and enters the 1/4 wavelength plate 806 from the second surface 855 of the polarized light beam splitter 844.

[0153]

Each beam that enters the 1/4 wavelength plate 806 is converted into circular polarized light.

[0154]

These beams of circular polarized light are then collimated at the collimator lens 245, and pass via the mirror 108 and the objective lens 203 before being directed on to the track 201a of the information recording medium 201.

[0155]

Return path light reflected at the track 201a passes via the objective lens 203 and the mirror 108 and enters the collimator lens 245, wherein this light is formed into convergent light.

[0156]

The return path light emitted from the collimator lens 245 enters the wavelength plate 806 and is converted into P polarized light before entering the second surface 855 of the polarized light beam splitter 844.

[0157]

Each return path light of P polarization, that enters the second surface 855 enters as convergent light centered around an angle of incidence of 45 degrees to the PBS film surface 818.

[0158]

As described above, in respect of P polarized light, regardless of the wavelength and irrespective of the angle of incidence within a determined range, the PBS film surface 818 passes the light (FIG. 9). Accordingly, each of these return path lights passes the PBS film surface 818 and is emitted from a third surface 853 of the polarized light beam splitter 844. As shown in the drawing, the normal line of the third surface 853 and the second surface 855 faces along the Y axial direction and the normal line of the first surface 817 along the X axial direction.

[0159]

Each of the convergent light return path lights thus emitted from the third surface 853 passes via the hologram elements 133 (FIG. 5) of the integrated device 112 and enters the light receiving regions 205 to 219.

[0160]

DPP tracking error signals, focus error signals and read signals are generated from the signals from the light receiving regions 205 to 219.

[0161]

Secondary laser light output from the secondary laser light source 128 of the integrated device 112 (FIG. 5) is

separated into three beams by the three beam generating means 132.

[0162]

Each of the beams separated at the grating 132 enters the third surface 853 of the polarized light beam splitter 844 along the Y axis before entering the PBS film surface 818 as divergent light having an angle of incidence centered around 45 degrees.

[0163]

As described above (FIG. 9), the PBS film surface 818 passes substantially 100 percent of secondary laser light of the 780 nm band from the secondary laser light source 128 regardless of the polarization. Further, these transmission characteristics of the PBS film surface 818 operate in respect of incident light having arbitrary angle of incidence within an determined range centered around 45 degrees to the PBS film surface 818.

[0164]

Accordingly, each beam of the secondary laser light passes the PBS film surface 818.

[0165]

Each said beam is then emitted from the second surface 855 before being converted at the wavelength plate 806 into for example, an appropriate elliptical polarization.

[0166]

Each beam thus converted into an elliptical polarization at the wavelength plate 806 is then collimated at the collimator lens 245 and irradiated on to the track 201a on the information

recording medium 201 after passing via the mirror 108 and the objective lens 203.

[0167]

Return path light reflected at the track 201a passes via the objective lens 203 and the mirror 108 and enters the collimator lens 245 before being formed into convergent light. This convergent light enters the wavelength plate 806 and is converted there again into for example an appropriate substantially linear polarization or another elliptical polarization.

[0168]

Each return path light thus converted enters the polarized light beam splitter 844 via the second surface 855, before passing the PBS film surface 844 and being emitted from the third surface 853.

[0169]

Return path light emitted from the third surface 853 is directed over the hologram elements 133 (FIG. 5) where these lights are separated into respective diffracted lights of order of ± 1 by the hologram regions 133L and 133R, and formed into respective spots on the light receiving regions 205 to 219.

[0170]

After each spot is thus formed on the light receiving regions 205 to 219, tracking error signals, focus error signals and read signals are generated for the secondary laser light based on the output from each appropriate light receiving region 205 to 219.

[0171]

Accordingly, this third embodiment furnishes the following effects in addition to the effects of the first and second embodiments.

[0172]

(1) The PBS film surface 818 has polarization selectivity in respect of the primary laser light even when the primary and secondary laser lights are divergent light or convergent, but does not have polarization selectivity in respect of the secondary laser light. Accordingly, when the integrated device 112 is used, even if the collimator lens 245 is disposed between the mirror 108 and the polarized light beam splitter 844 that should be used in common for the primary laser light and the secondary laser light, high performance of the optical pickup can be maintained.

[0173]

(2) As the primary laser light has intensity distribution 822 that extends longer in the direction parallel to the page surface in FIG. 8 and shorter in the direction orthogonal to that page surface and moreover is equivalent to the radial direction orthogonal to the track on the information recording medium 201, improved lens shift properties are realized.

[0174]

FIG. 10 is a schematic illustration of the structure of an optical pickup according to a fourth embodiment of the present invention.

[0175]

Like reference numerals are applied for elements of this fourth embodiment that are the same as those of the first and second embodiments and a description of those elements is omitted.

The optical pickup 500 of this fourth embodiment is similar to that of the third embodiment on the point of using a PBS film surface 918 have wavelength transmission characteristics as shown in FIG. 9. The optical pickup is also similar to that of the first embodiment in using an inclined surface 917 as a beam forming surface and in employing two collimator lenses 902 and 909.

[0176]

More specifically, it is further described as follows.

[0177]

As shown in FIG. 10, this optical pickup 900 comprises a primary laser light source 901 for emitting a primary laser light (650 nm) that is of sufficient power for recording, and an integrated device 112 further comprising a polarized light beam splitter 944 including a PBS film surface, a secondary light source emitting a secondary laser light (780 nm) that is of sufficient power for recording as well as light receiving means for receiving light from the primary and the secondary laser lights.

[0178]

Here, the primary laser light source 901 is of the same configuration as the primary laser light source 801, however the primary laser light source 901 is set in position in relation

to the polarized light beam splitter 944 such that the primary laser light source emits in the P polarized light direction.

[0179]

Further, the optical pickup 900 has three beam generating means 903, a first collimator lens 902 and a 1/2 wavelength plate 911 disposed between the primary laser light source 901 and the polarized light beam splitter 944.

[0180]

The three beam generating means 903 has the same structure as that of the three beam generating means 903.

[0181]

The first collimator lens 902 is of the same configuration as the collimator lenses 102 and 245.

[0182]

The wavelength plate 911 rotates the direction of polarization to S polarization when primary laser light emitted from the primary laser light source 901 is P polarized light.

[0183]

The polarized light beam splitter 944 has the inclined surface (beam forming surface) 917 for forming the cross sectional form of a beam of primary laser light entering the polarized light beam splitter 944 via the wavelength plate 911. This inclined surface 917 is of the same configuration and provides the same functions as the inclined surface 117 of the first embodiment.

[0184]

As shown in FIG. 10, this optical pickup 900 has a front

monitor 904 that is of the same configuration and provides the same functions as the front monitor 904.

[0185]

Further, the integrated device 112 of the optical pickup 900 is of the same configuration and provides the same functions as the integrated devices 112 according to the first to third embodiments as described above.

[0186]

As shown in FIG. 10, this optical pickup 900 further has a second collimator lens 909 disposed between the integrated device 112 and the polarized light beam splitter 944.

This collimator lens 909 has the same configuration and is of the same structure as the second collimator lens 109 of the first embodiment.

[0187]

The polarized light beam splitter 944 has a first prism 944a and a second prism 944b, and a PBS film surface 918 having the wavelength transmission characteristics shown in FIG. 9 at the joining face of these prisms.

[0188]

As shown in FIG. 10, the PBS film surface 918 is disposed at an angle of 45 degrees in relation to the X axis and Y axis set in the same manner as the X axis and the Y axis respectively as described with respect to the first to third embodiments,

[0189]

As shown in FIG. 10, the optical pickup 900 has a 1/4 wavelength plate 906, a mirror 108 and an objective lens 203

disposed between the polarized light beam splitter 944 and an optical disk 201.

[0190]

The 1/4 wavelength plate 906 has the same configuration and provides the same functions as the 1/4 wavelength plates 106 and 806.

[0191]

The optical pickup 900 furnishes basically the same effects as the optical pickup 800 according to the third embodiment.

[0192]

A point of difference between the effects of this optical pickup 900 and those of the optical pickup according to the third embodiment is that the cross sectional form of intensity distribution of the primary laser light in the case of the optical pickup 900 can be subject to beam formation, in the same manner as applies with the first embodiment.

[0193]

More specifically, it is further described as follows.

[0194]

As mentioned above, the primary laser light source 901 is set in position in relation to the polarized light beam splitter 944 such that the primary laser light is emitted as P polarized light. As shown in FIG. 10, here, the intensity distribution 922 of emitted primary laser light generally has an elliptical form, being of short diameter in the planar direction (the XY direction) of the page of FIG. 10, and a longer

diameter along the axis orthogonal to that page (the Z direction).

[0195]

After undergoing separation into three beams at the three beam generating means 903, the primary laser light emitted from the primary laser light source 901 and having P polarization is collimated at the collimator lens 902, and the direction of polarization is rotated 90 degrees to provide S polarized light at the 1/2 wavelength plate wavelength plate 911. At the time, the intensity distribution 922 of the emitted primary laser light has not been converted and is of the same elliptical form 922 as described above.

[0196]

Accordingly, when the primary laser light enters the inclined surface 917 this light undergoes beam formation in the same manner as applies with respect to the first embodiment, such that the cross sectional form thereof becomes substantially circular.

[0197]

Prior to entering the polarized light beam splitter 944, both the primary laser light and the secondary laser light pass the collimator lenses 902 and 909 and are therefore parallel light beams at the time of entering the polarized light beam splitter 944.

[0198]

FIG. 11 is a schematic illustration of an fifth embodiment according to the present invention.

[0199]

Like reference numerals indicate those elements that are similar or the same as the respective elements of the first embodiment and second embodiment.

[0200]

As shown in FIG. 11, the third embodiment is a two wave replay and recording optical system including the optical pickups 100, 240, 800 and 900 of the above first to fourth embodiments and a PU optical system 148 for a high density disk system having a laser source emitting for example 400 nm band laser light. In FIG. 11, the optical pickup 240 of the second embodiment is drawn to represent this two wave replay and recording optical system, however this could also be the optical pickups 100, 800 or 900 of the first embodiment, the third embodiment or the fourth embodiment respectively.

[0201]

Instead of the mirror 108 used in the first to fourth embodiments, this fifth embodiment has a mountain shaped prism 150 having a reflecting surface for directing the primary and secondary laser lights incoming from/outgoing to the optical pickups 100, 240, 800 and 900 in a direction perpendicular to the page, and a surface for directing a 400 nm band laser beam in the same direction.

[0202]

Further, this fifth embodiment has a two lens actuator 151 for operation of an objective lens 203 used for the primary and secondary laser lights and an objective lens 149 for the

400 nm band laser light in an integrated manner.

[0203]

The fifth embodiment so configured enables a replay and recording optical system using laser beams of three wavelengths to be easily constructed in a small and compact form.

[0204]

FIG. 12 is a schematic illustration showing a first embodiment for reference of an optical pickup according each of the embodiments of the present invention.

[0205]

Those elements of this fifth embodiment that are similar or the same as the elements of each of the above described embodiments have like reference numerals to indicate those elements and a description of such elements is omitted.

[0206]

In FIG. 12, this embodiment for reference of an optical pickup comprises for example light receiving and emitting element 339 for receiving and emitting laser light of 650 nm, a first collimator lens 302 for this 650 nm laser light, a dichroic mirror 318, a front monitor 304, secondary light receiving and emitting elements 341 for receiving and emitting 780 nm laser light, a second collimator lens 309, a wavelength plate 306, a mirror 308 and a polarized light hologram 340.

[0207]

In this configuration the polarized light hologram 340 separates or distinguishes light directed to an optical disk not shown in the drawing and light reflected from that optical

disk.

[0208]

Primary laser light from a primary integrated device 339 reflected from the optical disk returns to the primary integrated device 339 and is received by the light receiving elements inside the device. Further, secondary laser light emitted from a secondary integrated device 112 is reflected at the optical disk and then reflected at the dichroic mirror 318, before being received by the light receiving elements disposed in that secondary integrated device 341.

[0209]

Four light receiving and emitting functions are concentrated in two elements in this optical pickup.

[0210]

The integrated devices 341 and 339 are each of an integrated structure, and in comparison to each of the integrated devices described with respect to the above embodiments, the integrated devices of this fifth embodiment are relatively complex in structure. Further, as the polarized light hologram 340 is required a greater number of parts make up this optical pickup of the fifth embodiment.

[0211]

FIG. 13 is a schematic illustration showing a second embodiment for reference of an optical pickup according to the present invention.

[0212]

Those elements that are similar or the same as the

elements of each of the above described embodiments have like or similar reference numerals and a description of such elements is omitted.

[0213]

As shown in FIG. 13, the optical pickup according to this second embodiment for reference comprises a primary integrated device 401 further comprising respective laser light sources for outputting a primary laser light (having a wavelength of for example 650 nm) and a secondary laser light (having a wavelength of for example 780 nm), a first collimator lens 402, a first grating 403, a monitor 404, a PBS (polarized light beam splitter) 418, a wavelength plate 406, a second collimator lens 409, a birefringence prism 442 and a second integrated device 443 further comprising light receiving elements for receiving the primary laser light and the secondary laser light.

[0214]

In this optical pickup the primary laser light and the secondary laser light are emitted from the integrated device 401. After these laser lights are reflected at an optical disk the lights are reflected at the PBS 418 and pass via the collimator lens 409 and the birefringence prism 442 before being received at the light receiving elements 443.

[0215]

As shown in the drawing, in this embodiment for reference beam formation for two wavelengths is performed at the same prism. Normally, substantial chromatic aberration occurs when beam formation is performed at a single inclined surface thus

the coexistence of two wavelengths creates difficulties. Accordingly, in order to realize satisfactory optical properties in such a configuration, what is known as "achromatism" that uses a plurality of glass members for refractive index and a plurality of refractive interfaces is required, leading to increased complexity and costs.

[0216]

Further, the light emitting points of the primary laser light and the secondary laser light are mutually displaced in the horizontal direction along the forward traveling direction thereof. Accordingly the optical paths of the primary and secondary laser lights after the birefringence prism 442 can be matched over the light receiving elements 443. This results in an increase in the number of parts.

[0217]

The above described first and second embodiments of the present invention enable realization of a structure for a two wavelengths recording optical pickup that is both simple and compact.

[0218]

In other words, the above described first and second embodiments of the present invention provide a simple optical pickup that is compatible with recording type optical disk standards using 650 nm band region laser light such as for DVD-RAM, DVD-R, DVD-RW, DVD +R and DVD + RW or the like, as well as recording type optical disk standards using 780 nm band region laser light such as for CD-R or CD-RW or the like.

[0219]

Further, according to the above described embodiments, heat release is easily achieved when using a high output laser light source of for example the 650 nm band region.

[0220]

Again, the third embodiment provides an optical pickup suitable as a mutually compatible recording and playback system with a recording type optical disk using 400 nm band region laser light such as Blue-Beam Disc or the like.

[0221]

The above described embodiments of the present invention are illustrative and not restrictive.

[0222]

For example, the primary laser light may have wavelengths of either the 400 nm, 650 nm or 780 nm wavelength bands and the secondary laser light may have wavelengths of a wavelength band different to those of the primary laser light from either the 400 nm, 650 nm or 780 nm wavelength bands.

[0223]

[Effect of the Invention]

As described above, the present invention provides an optical pickup having a simple structure and that is capable of recording using a plurality of wavelengths.

[Brief Description of the Drawings]

[Fig. 1]

FIG. 1 is a schematic illustration of the structure of

an optical pickup according to a first embodiment of the present invention.

[Fig. 2]

FIG. 2 is a perspective view of a schematic illustration of the structure shown in FIG. 1.

[Fig. 3]

FIG. 3 is a schematic illustration of the structure of the polarized light beam splitter used for the first embodiment of the present invention.

[Fig. 4]

FIG. 4 shows wavelength reflection/transmission properties of the polarized light beam splitter shown in FIG. 3.

[Fig. 5]

FIG. 5 is a schematic illustration showing in outline the structure of the integrated device as an optical device used for the first embodiment according to the present invention.

[Fig. 6]

FIG. 6 is a schematic illustration showing in outline the structure of the light receiving elements disposed in the integrated device of FIG. 5.

[Fig. 7]

FIG. 7 is a schematic illustration of the structure of an optical pickup according to a second embodiment of the present invention.

[Fig. 8]

FIG. 8 is a schematic illustration of the structure of

a third embodiment according to the present invention.

[Fig. 9]

FIG. 9 shows wavelength reflection/transmission properties in the polarized light beam splitter disposed in the third embodiment of the present invention.

[Fig. 10]

FIG. 10 is a schematic illustration of the structure of an optical pickup according to a third embodiment of the present invention.

[Fig. 11]

FIG. 11 is a plan view showing a schematic illustration of the structure of an optical pickup according to an third embodiment of the present invention.

[Fig. 12]

FIG. 12 is a schematic illustration showing an embodiment of reference of an optical pickup according to the present invention.

[Fig. 13]

FIG. 13 is a schematic illustration showing another embodiment for reference of an optical pickup according to the present invention.

[Fig. 14]

FIG. 14 is a schematic illustration showing an example of a conventional optical pickup.

[Fig. 15]

FIG. 15 is a schematic illustration showing another example of a conventional optical pickup.

[Fig. 16]

FIG. 16 is a graph showing the wavelength reflection/transmission properties in the polarized light beam splitter used in the optical pickup of FIG. 15.

[Explanation of the Reference Numerals]

101, 241, 801, 901 primary laser light source

105, 244, 844, 944 polarized light beam splitter

112 integrated device

118, 818, 918 polarized light beam splitting (PBS) film surface

128 secondary light source

136 light receiving means (light receiving element)

[Name of Document] Abstract

[Abstract]

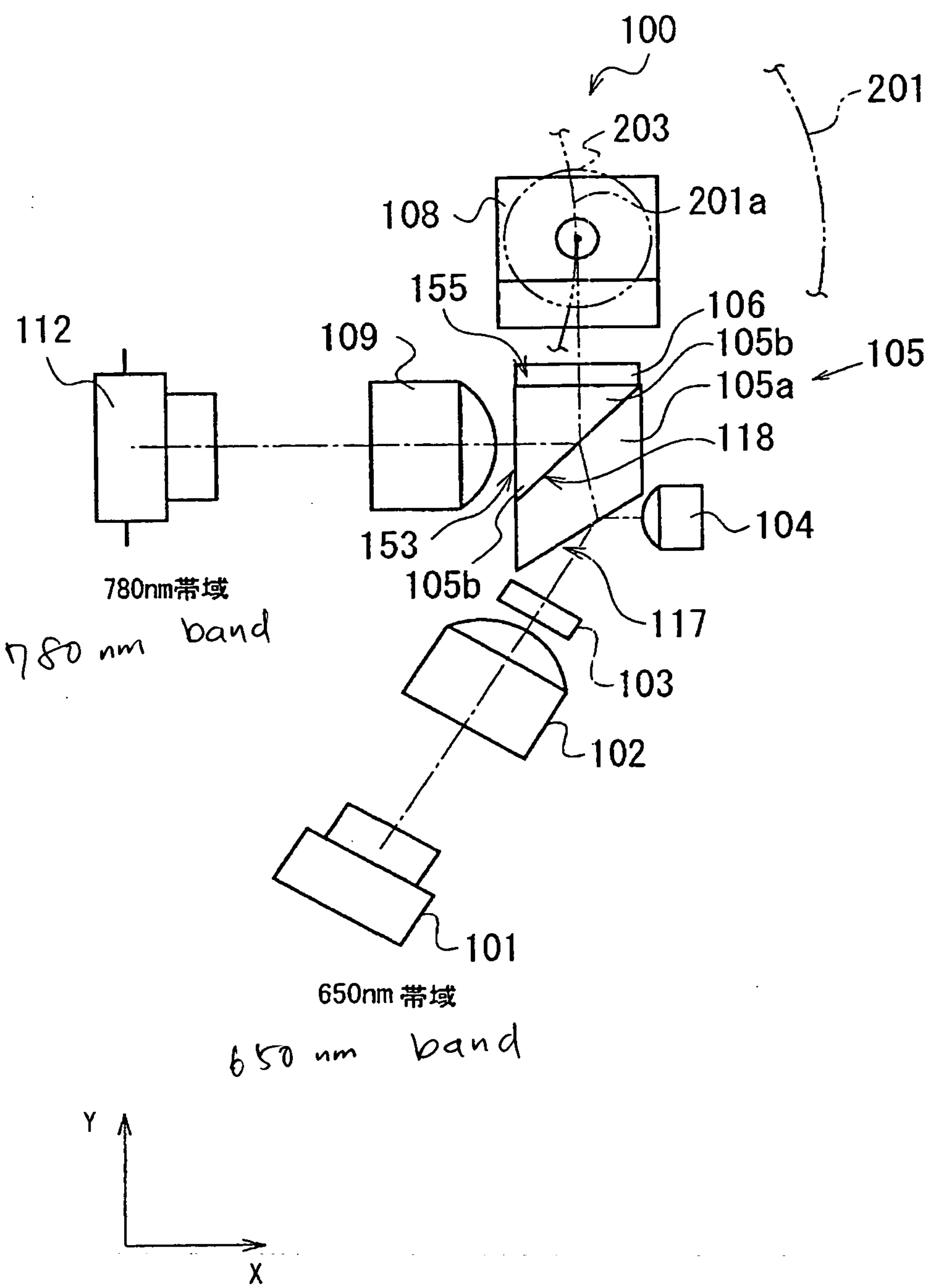
[Object] An optical pickup having a simple structure and that is capable of recording using a plurality of wavelengths is provided.

[Solving Means] An optical pickup comprising: a first laser beam source for emitting a first laser beam having a first wavelength and power capable of recording; an integrated device having a second laser beam source for emitting a second laser beam having a second wavelength longer than the first wave length and power capable of recording and receiving means for receiving the first and the second laser beam; and a polarization beam splitter having polarization selectivity for the first laser beam and polarization non-selectivity for the second laser beam.

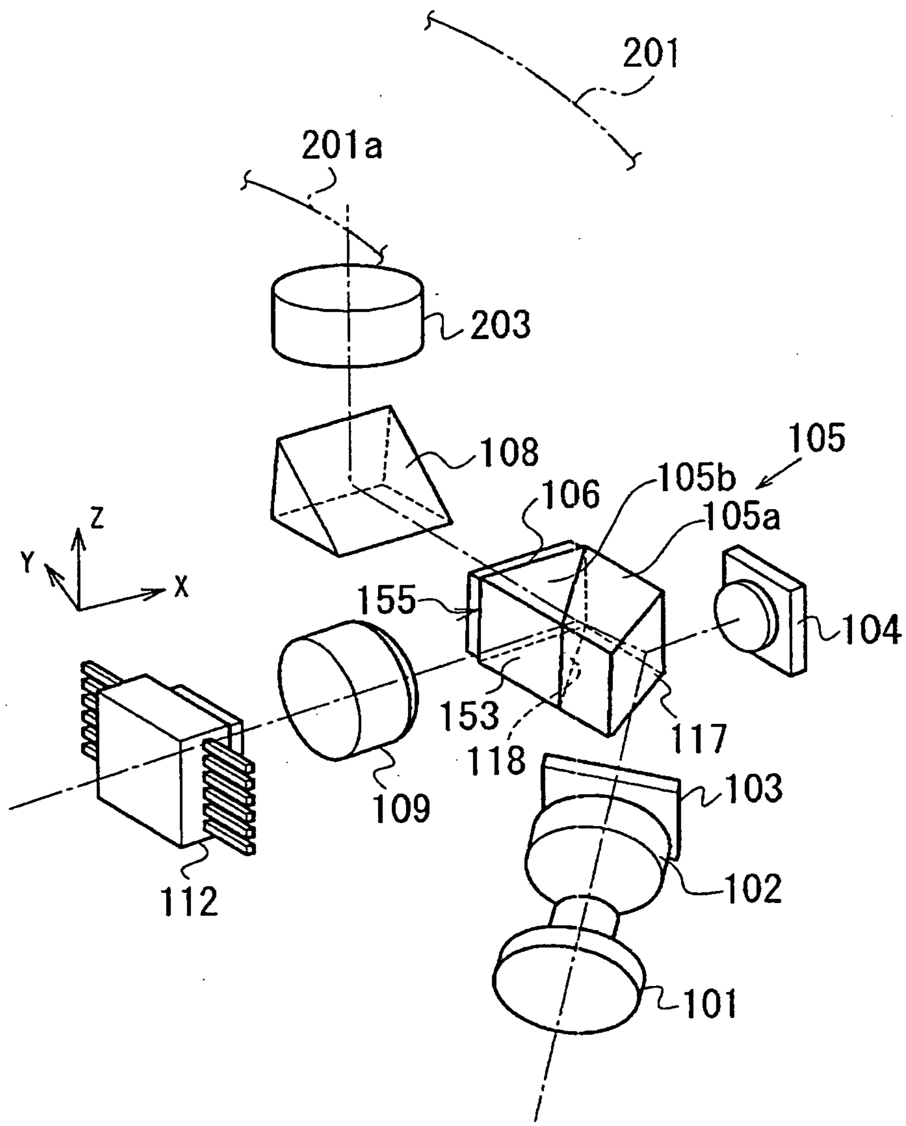
[Selected Figure] Fig. 8

【書類名】　図面　[Name of Document]　Drawings

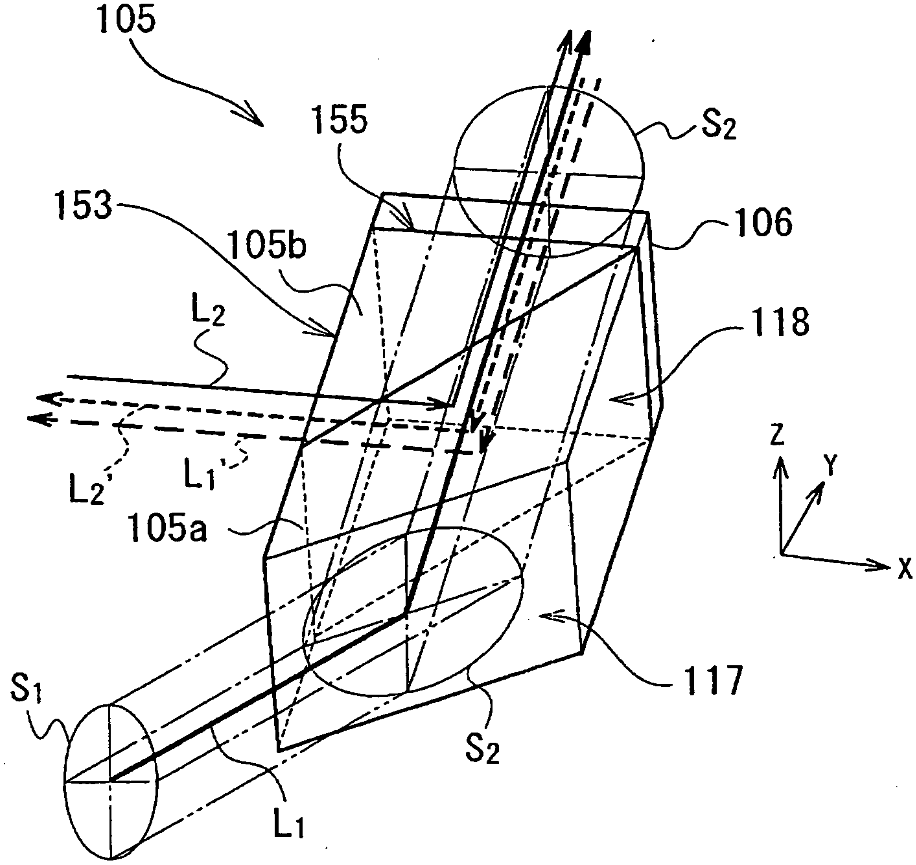
【図１】　[Fig. 1]



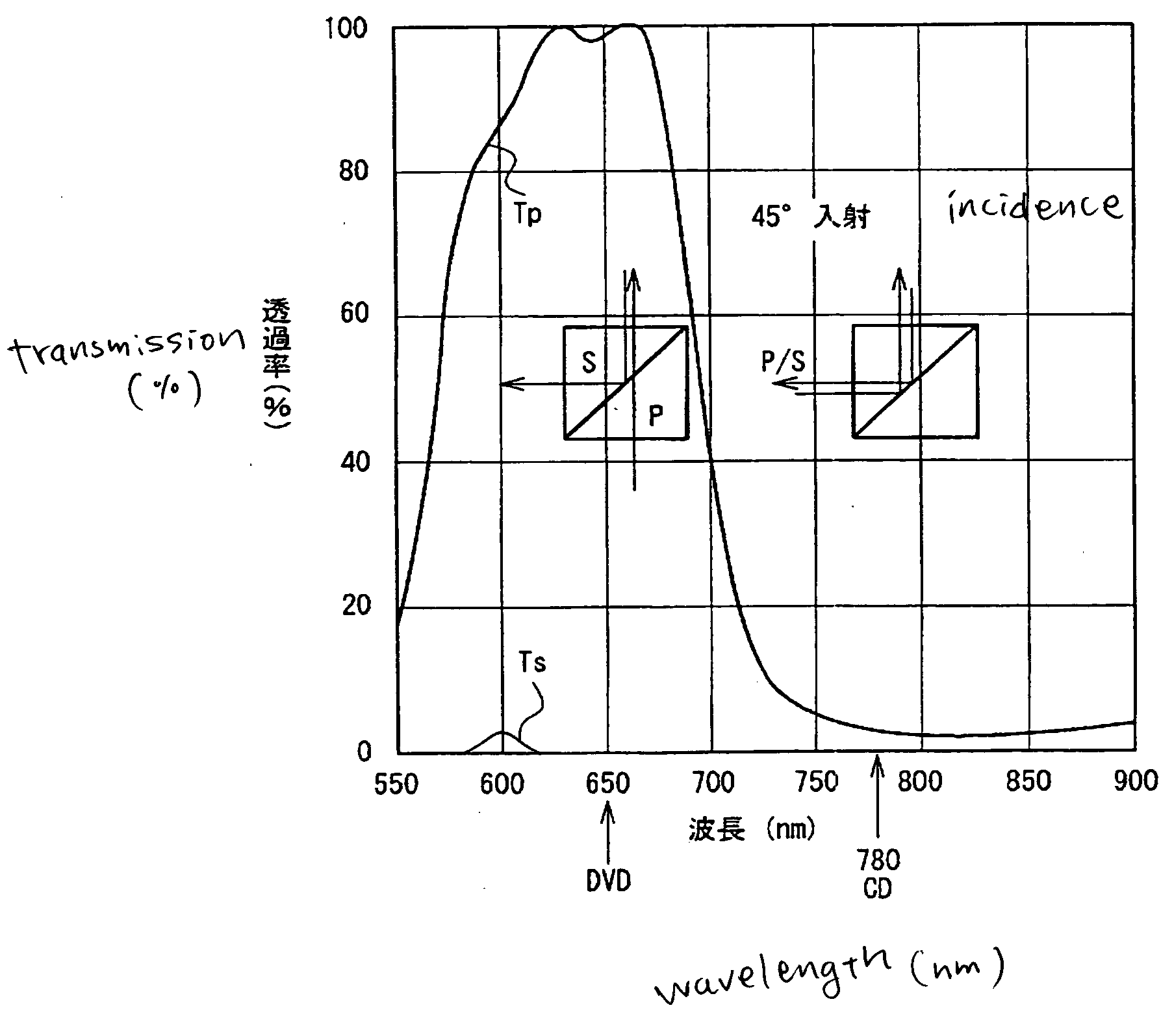
【図２】 Fig. 2


201
201a
203
108
105
106
105b
105a
Z
Y
X
155
104
153
117
118
103
109
102
112
101

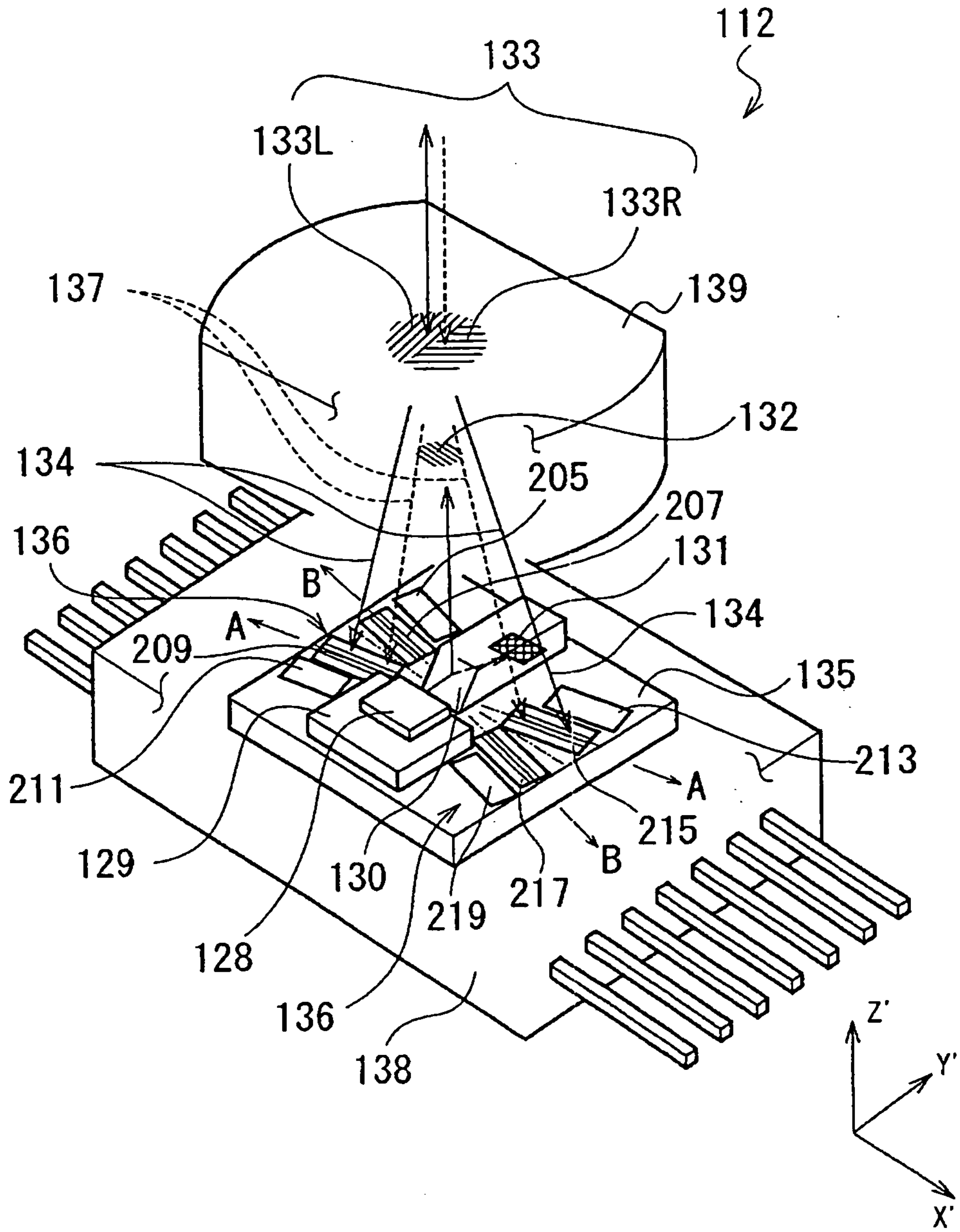
【図３】 Fig. 3



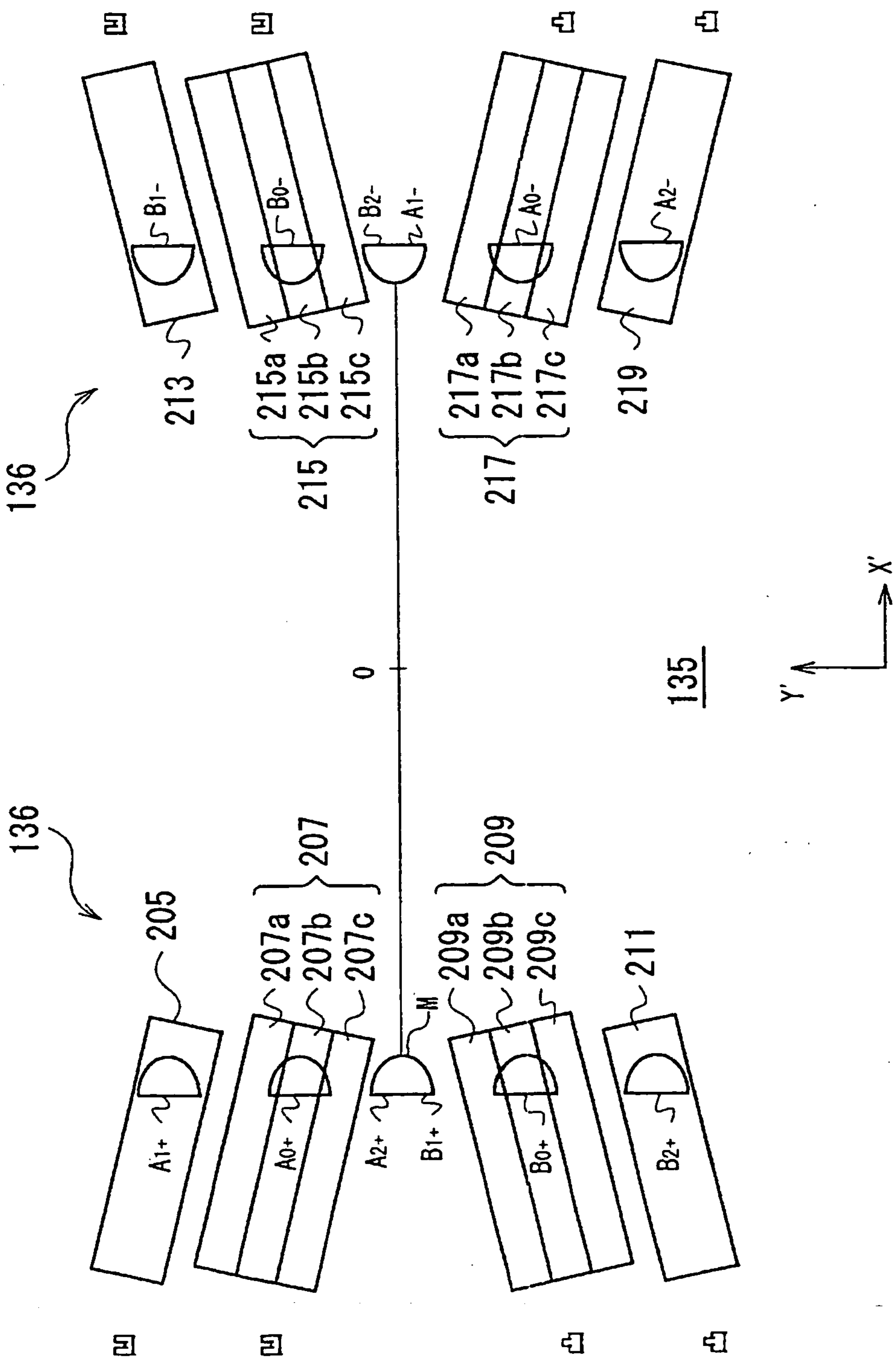
【図４】　Fig. 4


100
80
60
40
20
0
550
600
650
700
750
800
850
900
Tp
Ts
45°　入射
incidence
S
P
P/S
透過率(%)
transmission (%)
波長 (nm)
wavelength (nm)
DVD
780
CD

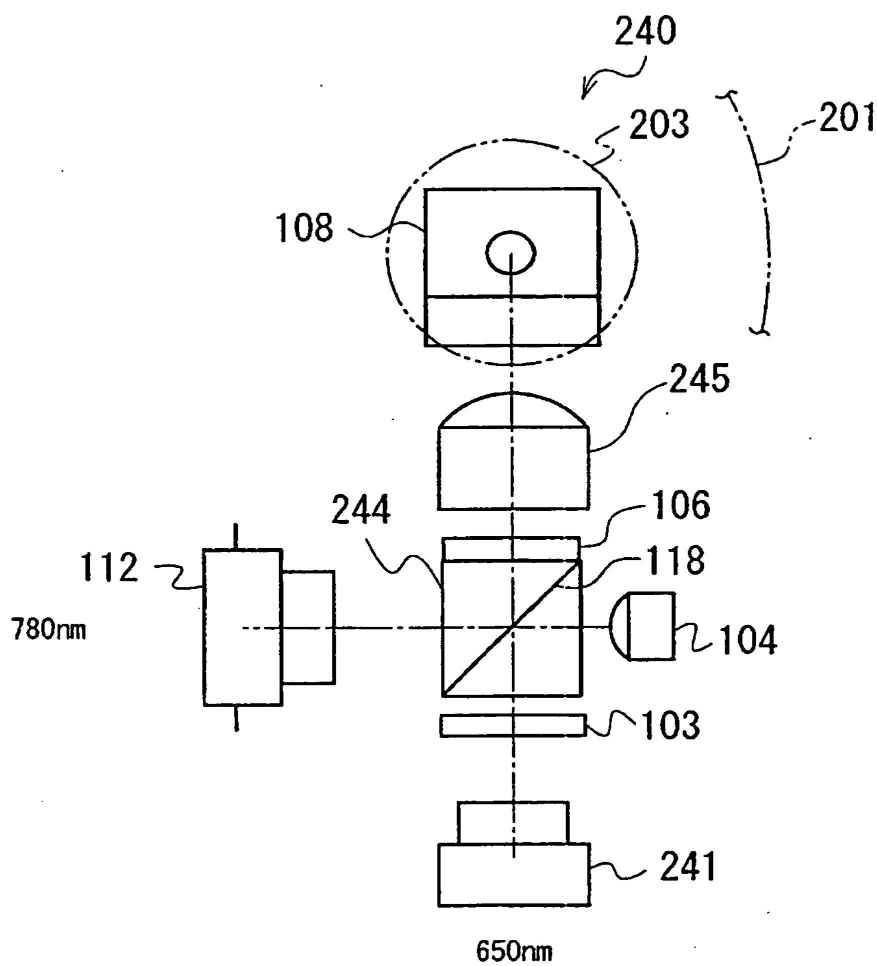
【図５】　Fig.5


112
133
133L
133R
137
139
132
134
205
207
136
131
B
A
134
209
135
211
213
A
215
129
130
B
217
219
128
136
138
Z'
Y'
X'

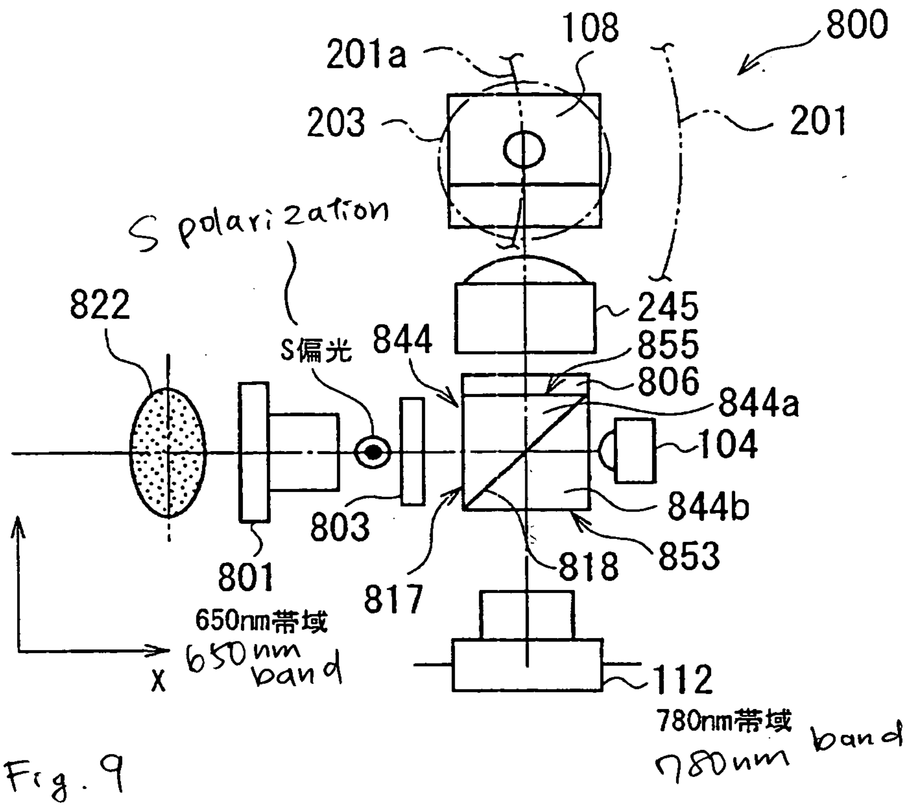
【図６】　Fig. 6


136
213
215a
215b
215c
215
217a
217b
217c
217
219
B1-
B0-
B2-
A1-
A0-
A2-
0
135
X'
Y'
136
205
207a
207b
207c
207
209a
209b
209c
209
211
M
A1+
A0+
A2+
B1+
B0+
B2+

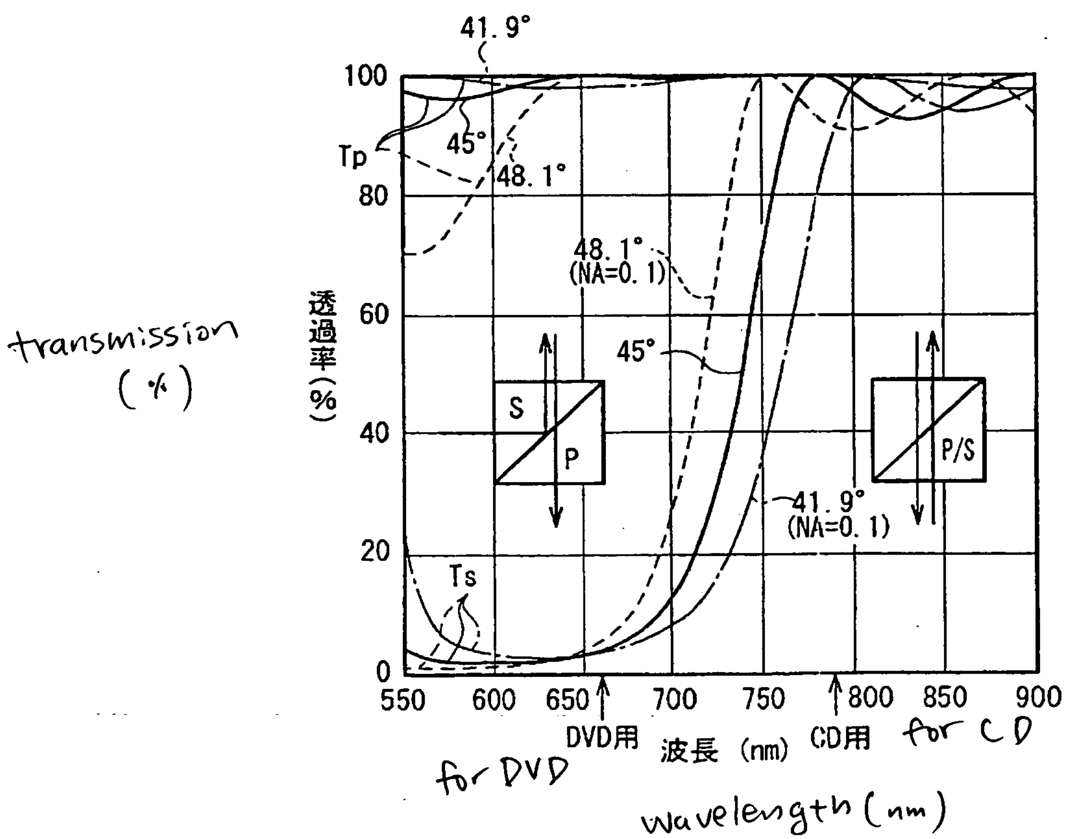
【図７】 Fig.7



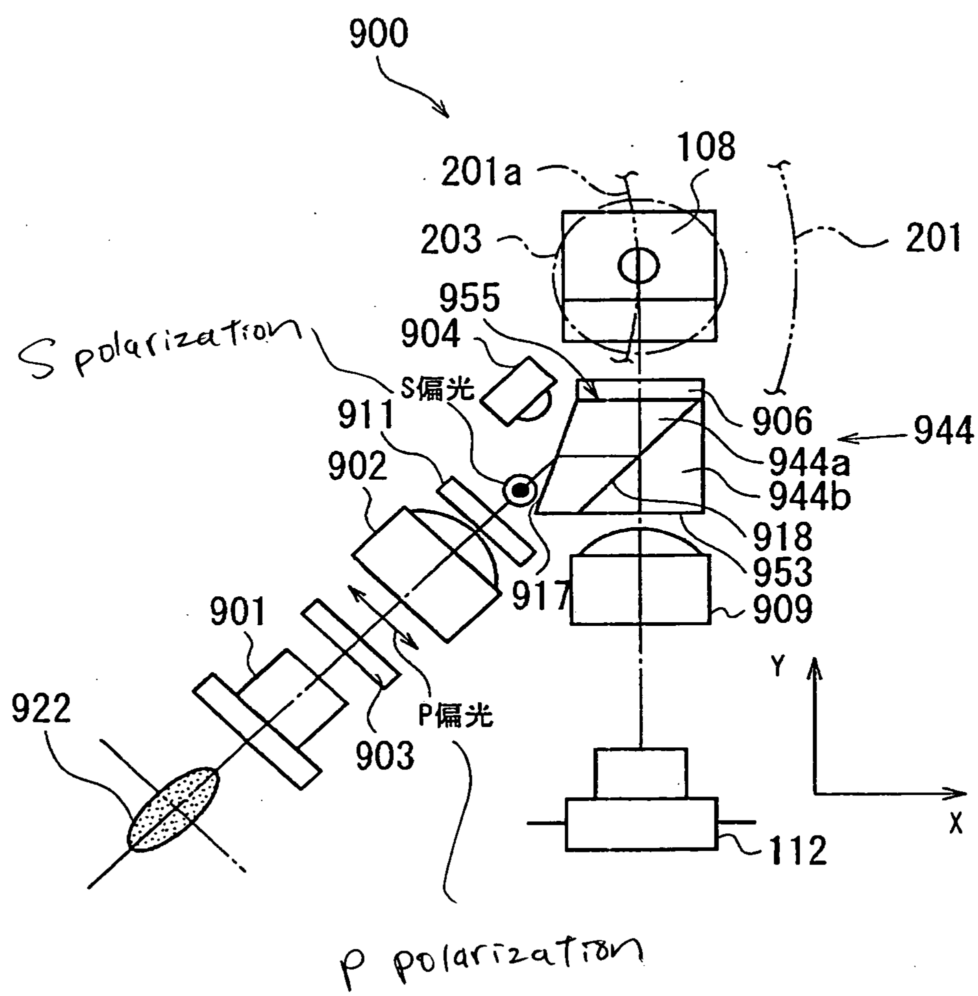
【図８】 Fig. 8



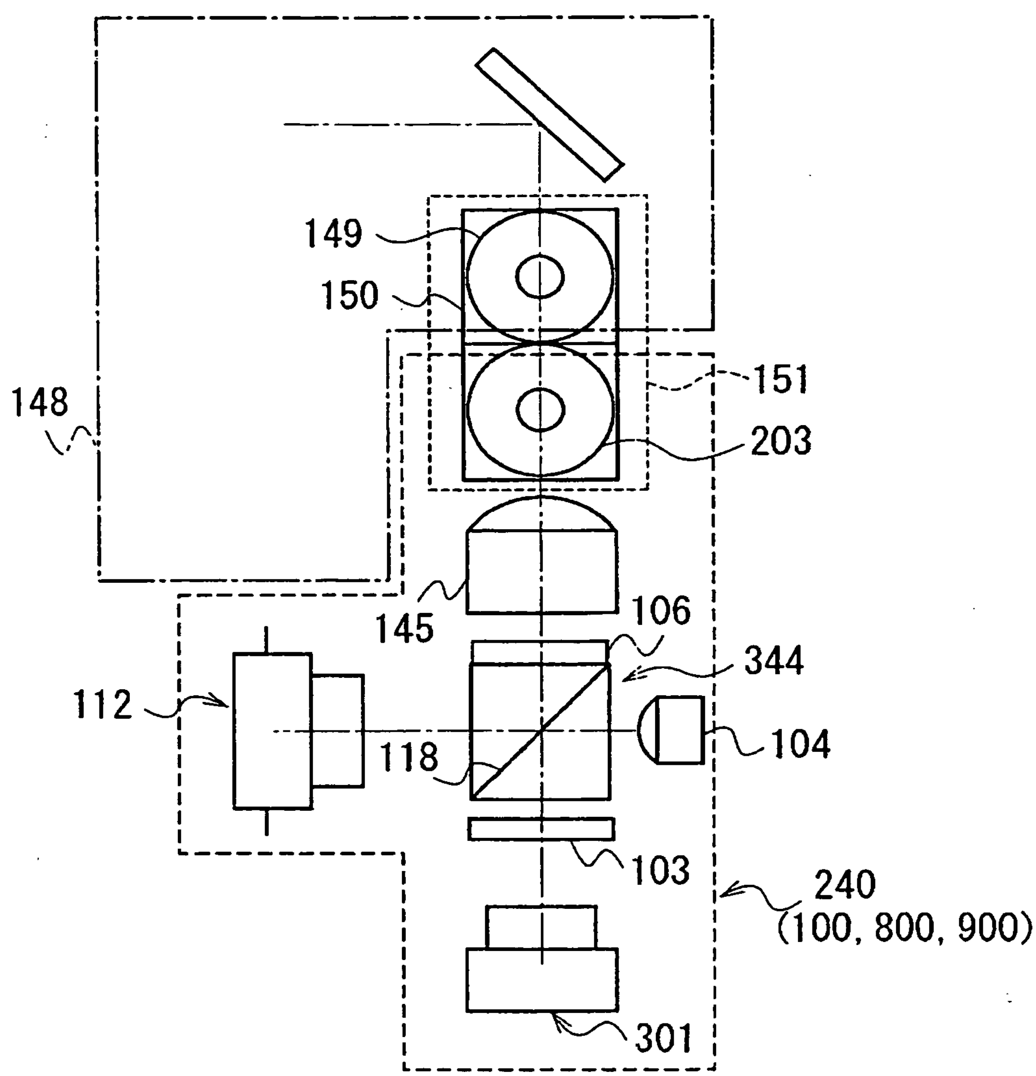
【図９】 Fig. 9



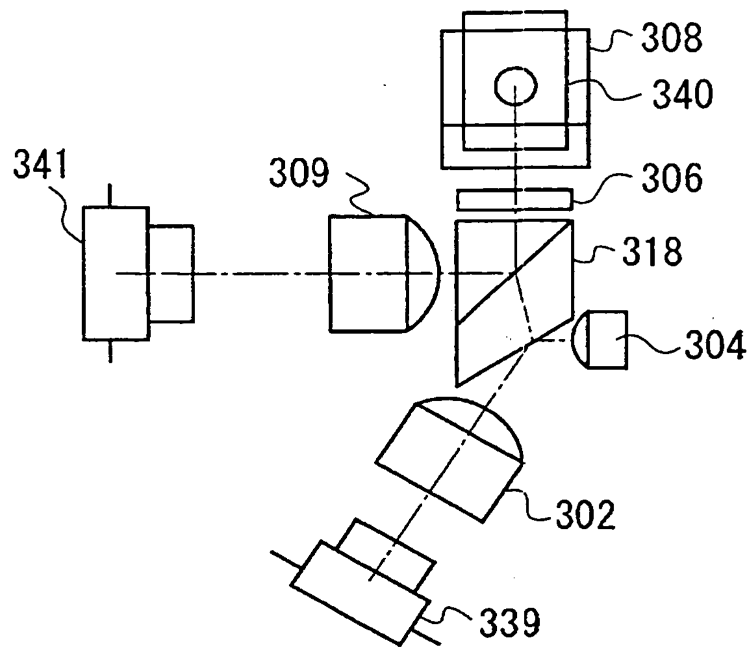
【図１０】　Fig. 10


900
201a
108
203
201
955
904
S polarization
S偏光
911
906
944
944a
944b
902
918
953
917
909
901
Y
922
903
P偏光
X
112
P polarization

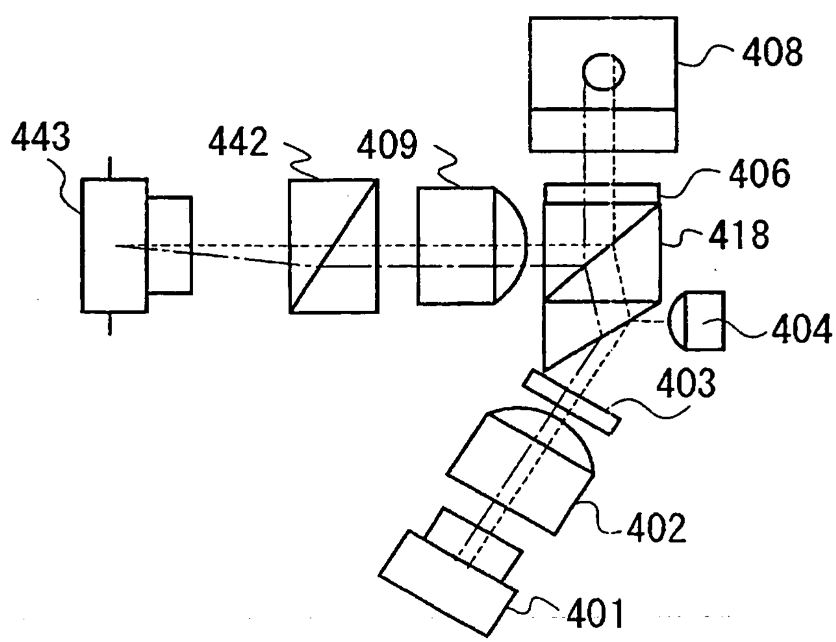
【図１１】　Fig. 11


149
150
148
151
203
145
106
344
112
118
104
103
240
(100, 800, 900)
301

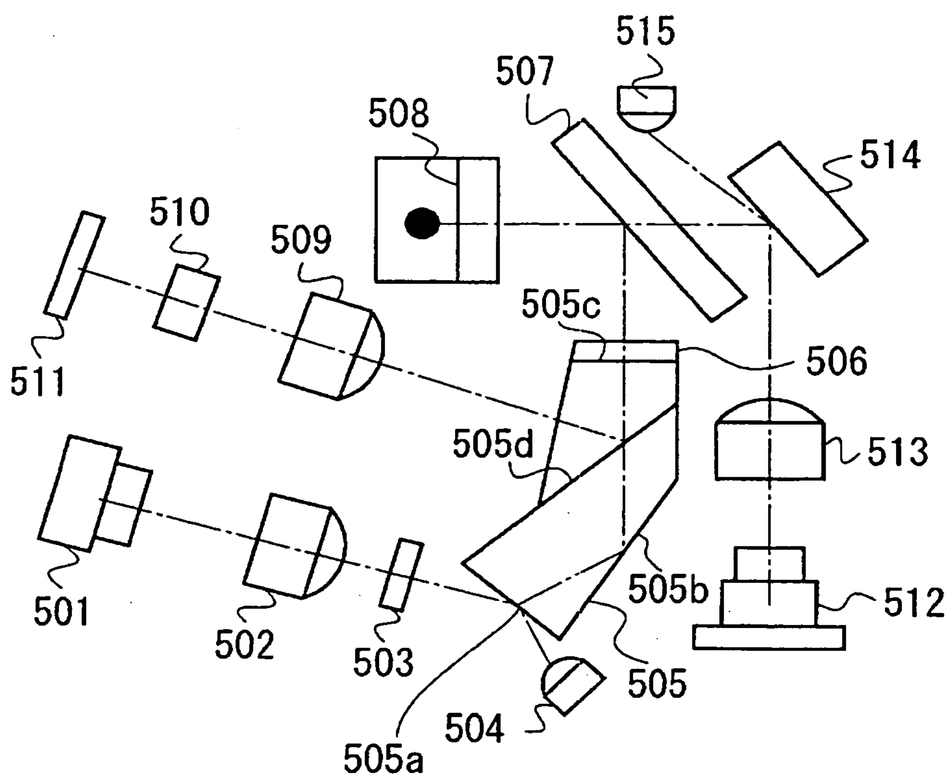
【図１２】　Fig. 12



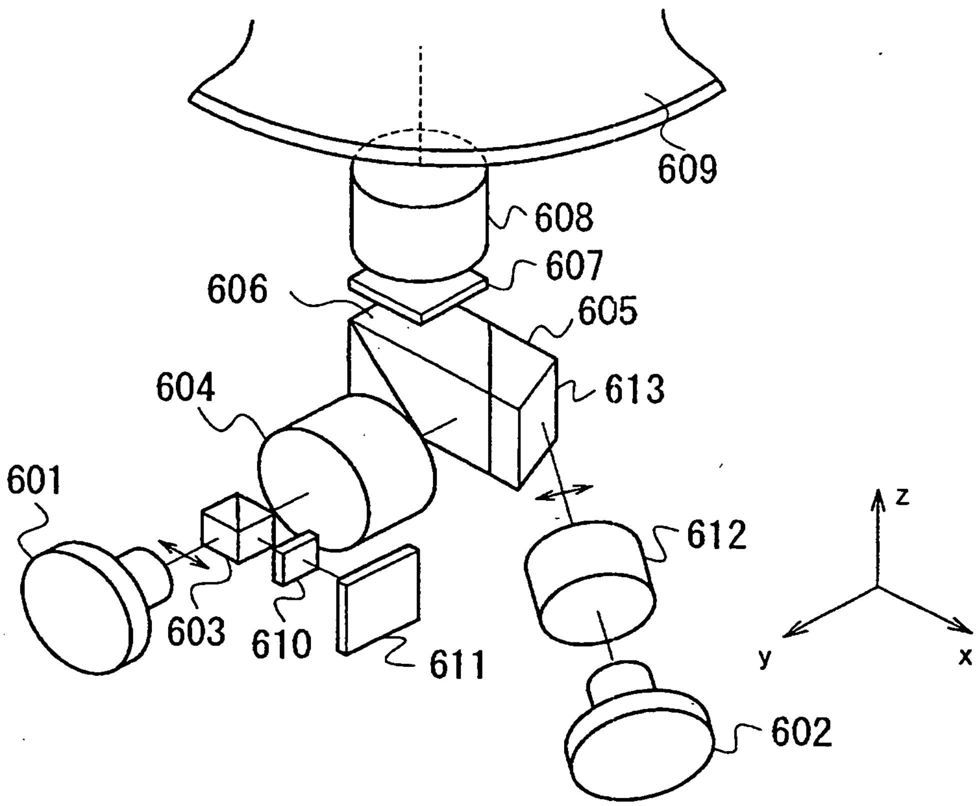
【図１３】　Fig. 13



【図１４】 Fig. 14


515
507
508
514
510
509
505c
506
511
505d
513
501
502
503
505b
512
505
504
505a

【図１５】　Fig. 15



【図１６】　Fig. 16